8-1982

Biochemical, Hematological, and Pathological Observations of Black Bears in the Smoky Mountains

William Joseph Cook
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by William Joseph Cook entitled "Biochemical, Hematological, and Pathological Observations of Black Bears in the Smoky Mountains." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

Michael R. Pelton, Major Professor

We have read this thesis and recommend its acceptance:

John C. New, Richard Strange

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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and recommend its acceptance:

Accepted for the Council:

L Evans Roth

Vice Chancellor
Graduate Studies and Research

BIOCHEMICAL, HEMATOLOGICAL, AND PATHOLOGICAL OBSERVATIONS

OF BLACK BEARS IN THE SMOKY MOUNTAINS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

William Joseph Cook

August 1982

ACKNOWLEDGMENTS

I am especially grateful to my major professor, Dr. Michael R. Pelton, who provided assistance and made this research possible. I also thank Dr. John New and Dr. Richard Strange who served on my committee and contributed valuable assistance and editorial comments on this manuscript. The personal and professional involvement of many different cooperators who provided technical support made this project possible. Microbiologists, clinicians, and parasitologists from the University of Tennessee College of Veterinary Medicine enthusiastically provided material, support and advice. Special appreciation is extended to Ms. Dottie Fenner and other personnel in the clinical pathology laboratory at the College of Veterinary Medicine.

Jim Crum, Parasitologist at the Southeastern Cooperative Wildlife Disease Study, Athens, Georgia made many helpful recommendations and provided technical support. Richard Conley and Doug Scott, Tennessee Wildlife Resources Agency, provided technical assistance and specimens. Dr. Edward Addison, Guelph, Ontario, provided adult specimens of *Dirofilaria ursi* for comparative purposes. The C. E. Kord Animal Disease Laboratory, Nashville, Tennessee, notably microbiologists John Black and H. J. Bingham provided serologic analysis of the sera samples. The University of Tennessee Center for Health Sciences, Knoxville, Tennessee, particularly the Departments of Pediatrics and Pathology, provided the use of laboratory facilities and equipment. Dr. Virginia Hinshaw, St. Jude Children's Research Hospital, Memphis, Tennessee provided testing capability for swine influenza virus specimens.

To the many fellow students including Tom Burst, Dan Eagar, Tom Eagle, Dave Garshelis, Danny Gray, Howard Quigley, John Eiler, and Ken Johnson who provided field assistance, trudged through the mountains throughout the summer while running traplines and collected specimens, your efforts are greatly appreciated.

Special thanks are extended to Stu Coleman and the resource management staff of the Great Smoky Mountains National Park for their encouragement and support.

My deepest appreciation goes to my wife, Patrese, for her encouragement, support and understanding.

This study was supported by funds made available from the Great Smoky Mountains Natural History Association, McIntire-Stennis Project No. 12, the Department of Forestry, Wildlife, and Fisheries, Agricultural Experiment Station, The University of Tennessee, Knoxville and the Tennessee Wildlife Resources Agency.

ABSTRACT

Selected tissues were collected from black bears in the Smoky Mountains between May 1976 and September 1980. Information related to the pathology of bears was accumulated and analyzed. Specimens were obtained from 290 bears.

Pathological studies included whole blood and serum biochemical parameters, a parasitic and infectious disease survey and gross and histological evaluation of tissues obtained from post mortem examinations. Whole blood specimens were analyzed for percent cell volume (PCV), hemoglobin (HGB), red blood cell count (RBC), white blood cell count (WBC), platelet count, estimated sedimentation rate (ESR), and reticulocyte count. Calculations were determined for erythrocytes including mean cell volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC). One hundred eighty-one peripheral blood smears were stained and hematopoietic tissues were examined microscopically to determine normal ranges and irregularities of pathologic significance. Differential counts of leukocytes were performed to determine relative abundance of cell series types. Erythrocytes were examined for irregularities in hemoglobin concentration, prematurity, inclusion bodies, and structural integrity.

One hundred thirty sera samples were analyzed for 24 biochemical parameters including glucose, blood urea nitrogen (BUN), creatinine, BUN/creatinine ratio, sodium, potassium, chloride, carbon dioxide,

uric acid, calcium, phosphorus, total protein, albumin, iron, cholesterol, triglyceride, alkaline phosphatase, lactic dehydrogenase (LDH), serum glutamicoxalacetic transaminase (SGOT), creatinine phosphokinase (CPK), total bilirubin, globulin, and albumin/globumin ratio. Electrolytic balance was also calculated. Statistical tests were performed on data for normal value and abnormal value associations of pathologic significance.

Urinalysis including biochemical and microscopic observations was performed on 8 urine specimens collected from immobilized bears.

Antibody titers for 5 serovars of *Leptospira interrogans* were determined from sera samples from 240 different bears. Fifteen bears were reactors (>1:50) for *L. canicola*, 36 bears exhibited titers for *L. icterohemorrhagiae*, 10 were reactors for *L. pomona*, 2 were reactors for *L. grippotyphosa*, and 1 bear had a titer for *L. hardjo*. A total of 64 bears were reactors (26.6%). Nine bears were reactors for more than one serovar.

One hundred seventy-eight bears were tested serologically for canine distemper virus. Fifty-two reactors (29.2%) were determined for 1978-79 but no reactors were found in 1977 (n=47).

Antibody titers were examined for 2 serotypes of *Brucella*. Two hundred forty bears were tested for *Brucella canis* and 67 were tested for *B. abortus*; no reactors were determined.

Sixty-seven sera samples were submitted for antibody titers to infectious bovine rhinotracheitis, swine parvovirus, and pseudorabies. All specimens were collected during the 1978-79 period. No reactors were found. Sixty samples were negative for canine parvovirus titers.

Attempts to culture *Bordetella bronchiseptica* from 42 nasal swab specimens were negative. Fifty sera samples were tested for *Bordetella* antibodies but no reactors were observed. Forty-two sera, nasal, and rectal specimens were negative for swine influenza.

While performing whole blood cell morphologic observations, microfilariae of *Dirofilaria ursi* were observed. A total of 205 whole blood samples were examined for the presence of microfilaria. One hundred sixty-eight (81.9%) of the samples contained this parasite. Only 10 diaphragm specimens were available for determination of *Trichinella spiralis* larvae; no larvae were found.

Very little information was obtained from the post mortem examination of 10 bear carcasses. Fifty-three carcasses or carcass remnants were examined in the field. Radiologic examinations were performed for determination of the presence of lead or other artifacts related to illegal hunting activity. Forty carcasses were determined to have been illegally killed. The use of radiologic techniques to assist in the post mortem examination of wildlife proved to be a valuable tool.

The prevalence of antibody titers to infectious diseases and the presence of *D. ursi* provided information on the conditional status of bears. A descriptive epidemiological approach to the temporal and spatial aspects of the observations was used. Based on the information accumulated, the bear population in the Smoky Mountains appears to be in good condition. The influence of infectious diseases is inapparent. Development of wildlife forensic techniques and their determinations provided additional information previously not available for the protected bears in the Great Smoky Mountains National Park.

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CHAPTER I

INTRODUCTION

In the eastern United States the ursine family is represented by the black bear, Ursus americanus, an animal that symbolically represents wilderness and associated values. Black bears once inhabited almost all the forested areas of North America. Destruction of habitat and indiscriminate slaughter by people resulted in reductions in populations, especially in the eastern United States. The Great Smoky Mountains National Park (GSMNP or Park) probably has the largest protected population of bears in the southeastern United States (LaFollette 1974).

The decline in bears fortunately has stimulated attempts to develop more conscientious efforts to conserve this large mammal. Public attitudes are changing from considering the bear a pest species to recognizing it as an animal with unique aesthetic qualities. The need to better manage bears has resulted in accelerated research to obtain basic data (Schnoes and Starkey 1978). Adequate information on which to base management policy is scarce, particularly in subject areas of covert mortality factors such as infectious and parasitic diseases.

Addison (1976) documented the biology of Dirofilaria ursi in black bears in Ontario. Helminth and arthropod parasites of black bears in central Ontario were described (Addison et al. in press) and Bowmer (1973) documented ursine trichinosis in British Columbia.

LeCount (1981) found a low number of bears infected with trichinosis in Arizona. Parasitological surveys in black bears have been described in New York (King and Hadley 1968) and Quebec (Juniper 1978). In the southeastern United States, Hamilton (1978) and Crum et al. (1978) described parasitism in black bears. Cook and Pelton (1979) described selected infectious and parasitic diseases of black bears in the Great Smoky Mountains National Park. An expansion of this survey resulted in this research effort which includes an initial survey for selected infectious diseases never reported before for wild black bears.

Extensive research has been conducted on black bears in the Smoky Mountains since 1969. Studies have related to population characteristics, movements, activity patterns, population density, food habits, den ecology, and capture and immobilization (Marcum 1974, Beeman 1975, Beeman and Pelton 1980, Burst 1979, Eagar 1977, Eagle 1979, Garshelis 1978, Garshelis and Pelton 1980, 1981, and Johnson and Pelton 1979, 1980a, 1980b). Tate and Pelton (1980) analyzed human-bear interactions of front country areas in the Park. Reproductive studies (Eiler 1981), blood parameter studies (Beeman and Pelton 1979, Beeman 1981, Eubanks et al. 1976), and aging techniques (Eagle and Pelton 1978) have contributed substantially to the biological information available concerning black bears in the Smoky Mountains.

Knowledge of the conditional status of a species, especially the influences of infectious and parasitic diseases is an important determinant for insuring survivability. Behavior patterns, reproductive potential, movement ecology, activity, and mortality can all be altered by the acute or chronic influences of diseases. Significant levels of disease are considered to be a function of an imbalance in the population/environment relationship. Manifestations of this imbalance range from a decline in reproductive rate to multiple, often repetitive problems associated with nutritional deficiencies and infectious agents (Schwabe et al. 1977). Accompanying the need for intensive management of wild populations is the necessity for developing additional knowledge concerning ecological, pathological and epidemiological associations. A multidisciplinary approach is the most advantageous method for developing knowledge relating the impacts of diseases on wild populations.

The conditional status of black bears, particularly the influence of infectious and parasitic diseases had not been determined. A preliminary survey (Cook and Pelton 1979) was initiated to ascertain the serologic evidence of selected infectious diseases and to determine the prevalence of Dircfilaria ursi in black bears. Additional data were collected to more completely document infectious, parasitic, and mortality factors associated with bears. Limitations on diagnostic procedures in this protected species allowed for only noninjurious methods to be used to determine disease prevalence. Utilization of antibody titers for determining the immunologic response to pathogens was interpreted for the significance those pathogenic agents can have on bears and other species.

The objectives of this study were to determine the role diseases assume and obtain base line data for noticeable pathological observations of black bears in the Smoky Mountains. No attempt was made to explain the variances of each and every hematological and biochemical parameter. Whole blood and its constituents were examined with meticulous attempts to document abnormalities both macroscopically and microscopically. Research objectives were: (1) identify infectious and parasitic fauna; (2) determine the distribution, prevalence, and intensity of infections; (3) evaluate the pathogenicity of each parasite and infectious agent; and (4) develop information relating to the associated pathology of illegally killed bears.

CHAPTER II

STUDY AREA

The principal study area was the Great Smoky Mountains National Park, an International Biosphere Reserve comprising 2,072 km^2 in eastern Tennessee and western North Carolina. That portion of the Park in the northwestern quadrant west of the transmountain road (U.S. Highway 441) and north of the prominent ridge delineating the state boundary was the area where this study was primarily conducted. Research was also conducted in the Cherokee National Forest, specifically the Tellico Ranger District bounded by the Tennessee-North Carolina state line, the Tellico-Robbinsville Road, and the Tellico River. The area is located between 35°20' and 35°47' N latitude and 83°05' and 84°20' W longitude in Blount, Sevier and Monroe counties, Tennessee (Fig. 1).

Most of the terrain in the study area is mountainous and accessible only by foot trails. The few improved and unimproved roads are located at lower elevations. Over 90% of the surface consists of slopes greater than 10% (Message from the President 1902). Elevations range 230 m at the intersection of the Tellico and Little Tennessee Rivers to 2,025 m at Clingman's Dome.

The Great Smoky and Unicoi Mountains are part of the Unaka Mountain Range of the Blue Ridge Province in the southern division of the Appalachian Highlands (Fenneman 1938). Soil types in the area are broadly categorized in the Ramsey association with most mountain slope

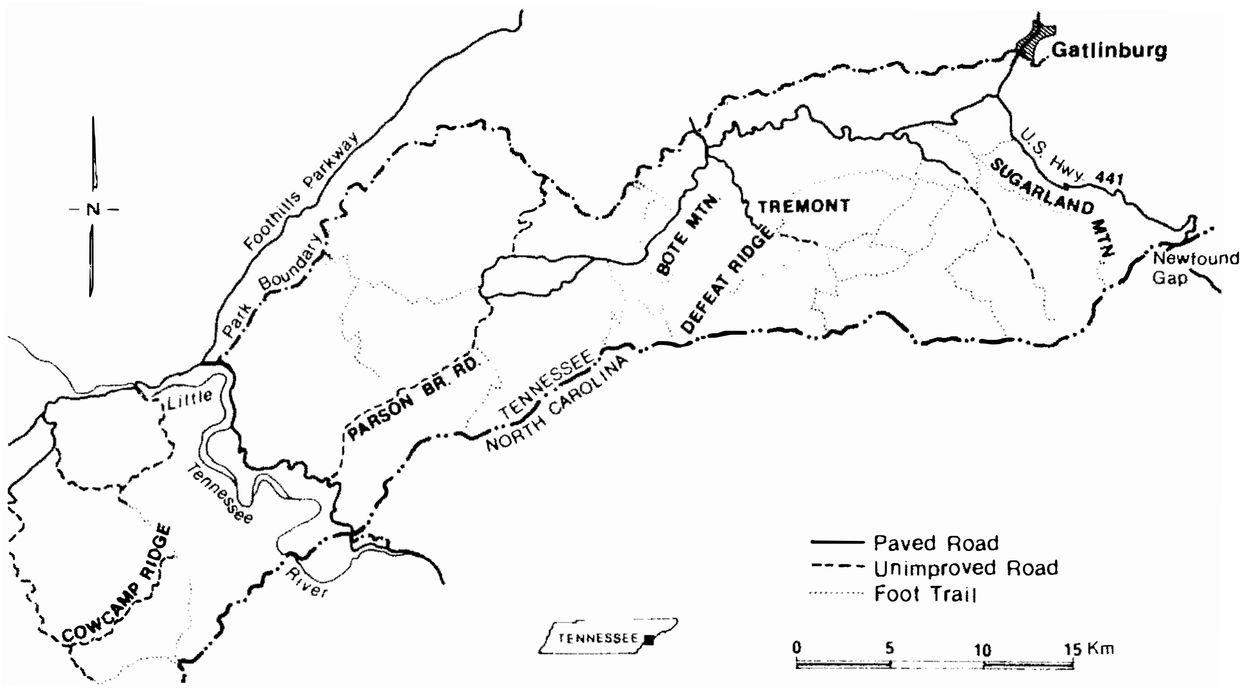

Fig. 1. Map of the study area, the northwestern section of the Great Smoky Mountains National Park and the Tellico Ranger District of the Cherokee National Forest.

soils in the Ramsey series and lower slopes in the Jefferson series. These soils are characterized by low water storage capacity, medium to high acidity and moderate fertility (Soil Survey 1945, 1953). Most parent material is feldspathic sandstone, siltstone, and conglomerate from the Ocoee series of the late Precambrian (King et al. 1968).

The vegetation is dense and highly diverse with much dispersion of forest types. It includes over 1,300 species of flowering plants of which 131 represent native trees, approximately 350 mosses and liverworts, 230 lichens, and more than 2,000 species of fungi (Stupka 1960). The classification by Shanks (1954) is the simplest and most widely used. The remaining spruce-fir is located at the highest elevations. Northern hardwoods occupy the slopes below the spruce-fir and the exposed slopes within the spruce-fir range. Cove hardwoods occur in the sheltered valleys, while open oak-pine stands and heath thickets occur on dry exposed ridge tops. Closed oak forests occupy slopes with intermediate exposure. Hemlock forest types are found along streams and sheltered slopes up to 1,100 m. Much of the understory is rhododendron (Rhododendron maxima) and mountain laurel (Kalmia latifolia). Vaccinium spp. and Gaylussacia spp. are common understory shrubs in the open oak-pine forest. A few grassy balds are found at higher elevations along the prominent ridgeline.

The Tellico Ranger District is managed for multiple use and sustained yield of timber, wildlife resources and recreation. Timber is managed under an even aged rotation. The Cherokee National forest is considered a wildlife management area, managed by the Tennessee

Wildlife Resources Agency (TWRA). Approximately 120 km^2 of the Tellico Ranger District is managed as a bear sanctuary. Other areas are periodically open to dog training and hunting during the fall.

Precipitation and temperatures vary greatly with elevation. The climate may be characterized generally as mesothermal prehumid warm temperature rain forest (Thornwaite 1948). At low elevations precipitation averages about 140 cm per year, but over 220 cm may occur at the higher elevations. Average annual temperature varies from 14°C at elevations below 450 m to 8°C at elevations over 1,900 m with a temperature gradient of 4°C per 1,000 m change in elevation. Most precipitation occurs during late winter or early spring and July-August. September and October receive the least precipitation. Lowest temperatures occur during February and highest temperatures in July (U.S. Dept. of Commerce 1972).

There are approximately 59 species of mammals inhabiting the study area, nearly half of which are in the order Rodentia (Linzey and Linzey 1971). Large mammals include white-tailed deer (<u>Odocoileus virginianus</u>) and the European wild hog (<u>Sus scrofa</u>). More than 200 species of birds, 23 species of snakes, over 72 species of fish, and a tremendous variety of salamanders are found within the area (National Park Service 1980).

CHAPTER III

MATERIALS AND METHODS

Capture and Handling Techniques

Bears were captured using Aldrich spring activated snares, modified culvert traps consisting of 2, 50 gallon barrels welded together with an angle iron door frame and a plywood door, and large trailer mounted culvert traps. Free range immobilization was accomplished using combinations of Rompun (Xylazine, Haver-Lockhart, Inc., Shawnee, KS), Carbocaine-V (Mepivacaine hydrochloride, Winthrop Laboratories, New York, NY) and Ketaset (Ketamine hydrochloride, Bristol Laboratories, Syracuse, NY). Dosage levels were in a ratio of 100 mg Rompun:200 mg Ketaset:20 mg Carbocaine in a lyophilized mixture administered 1.0 cc per 22.7 kg body weight. Other immobilization drugs used included M99 (Etorphine hydrochloride, D-M Pharmaceuticals, Inc., Rockville, MD) at dosages of 1.0 mg/45.5 kg and Sernylan (Phencyclidine hydrochloride, Parke Davis and Co., Morris Plains, N.J.) at 1.0 mg/kg dosage levels. Bears trapped in Aldrich snares or free range captured were immobilized using a Cap-chur syringe fired from a CO_2 pistol (Palmer Chemical and Supply Co., Inc., Douglasville, GA). A syringe mounted on a rod was used to immobilize bears caught in culvert and barrel traps.

Basic biological data were recorded for each animal and bears were marked with ear tags and lip tattoos to facilitate future identification. A first premolar was extracted for age determination from tooth sections prepared and stained as described by Eagle and Pelton (1978).

Whole Blood and Sera Preparation and Analysis

Blood samples were collected from the femoral or external iliac veins into evacuated glass tubes inserted into a Vacutainer Luer adapter attached to a 20 gauge needle (Becton-Dickinson, Rutherford, NJ). In order to obtain sera, blood was collected in Vacutainer chemistry tubes with no additive and allowed to clot. Whole blood was collected in Vacutainer tubes with EDTA (dipotassium salt of ethylenediaminetetraacetate) as the anticoagulant. Blood smears were prepared on microscope slides at the trap site or later from the anticoagulated specimens. Blood samples were transported when possible in small styrofoam coolers with refrigerant or ice added. All specimens were refrigerated immediately at the Tremont field laboratory. Specimens were transported either to The University of Tennessee Center for Health Sciences, Department of Pediatrics Clinical Laboratory or to the College of Veterinary Medicine Clinical Pathology Laboratory, Knoxville, Tennessee for further processing. Styrofoam containers were used to keep the samples cool for additional transportation to the clinical laboratories. Serum samples were rimmed, clots removed and centrifuged at 3,000 rpm for 15 minutes in a clinical centrifuge (Clay-Adams, Inc., Rutherford, NJ). Serum was pipetted and placed in additional tubes and frozen for later analysis.

Blood smears were stained with modified Wright-Giemsa stain (Davidsohn and Henry 1974). Hematocrits or the percent cell volumes

(PCV) were determined by the microhematocrit method using capillary tubes, a microhematocrit centrifuge, and an abcissa reader (Clay-Adams, Inc., Rutherford, NJ) (Davidsohn and Henry 1974). Whole blood samples were gently tilted for at least 5 minutes to insure proper mixing and blood was diluted with isotonic saline and prepared for calculation of PCV, hemoglobin (HGB), erythrocyte count (RBC), leucocyte count (WBC), mean cell volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and thrombocyte count. These values were determined on a Coulter Model F (Coulter Diagnostics, Inc., Hialeah, FL) with an upgraded computerized MCV and PCV calculator. Blood smears were also prepared and stained with new methylene blue for reticulocyte counts. Estimated sedimentation rates were determined by using the Westergren method (Davidsohn and Henry 1974).

Two methods were used for determining the presence of microfilaria of Dirofilaria ursi in the whole blood; 1.0 cc of whole blood was added to 9.0 cc of 2.0% formalin, blood cells allowed to disintegrate, and centrifuged for 10 minutes. The supernatant was poured off and the remaining residue placed on a microscope slide for microscopic observation of microfilaria (Soulsby 1968). The second method involved microscopic observation of microfilaria on the stained blood smear. Measurements were taken using a micrometer and compared to specimens supplied by E. M. Addison, Guelph, Ontario. Several references were used to characterize the dimensions of the microfilaria for speciation (Addison 1976, Anderson 1952, Crum 1977, and Crum, personal communication 1979).

Blood smears were examined under 1,000x magnification using a light filtered oil immersion lens on a compound, binocular microscope (American Optical Co., Buffalo, NY). Erythrocytes were examined for irregularities in hemoglobin concentration, prematurity, inclusion bodies of pathologic importance, structural integrity not reflective of counting methods, and intra- and extracellular inclusions of parasitic origin. The presence of nucleated red blood cells was recorded by the number of nucleated cells per 100 white cells counted (Diggs et al. 1970).

By differential counting, 100 leucocytes were counted to calculate a percentage of each type of cell observed. Particular attention was noted for cell maturation indicative of acute versus chronic infection due to parasitic, viral or bacterial influences. Leucocytes were also observed for toxic granulation, inclusion bodies, and other cellular pathology (Diggs et al. 1970, Schalm et al. 1975, and Brown 1976).

Serum samples were analyzed for biochemical parameters including glucose, blood urea nitrogen (BUN), creatinine, BUN/creatinine ratio, sodium, potassium, chloride, carbon dioxide, uric acid, calcium, phosphorus, total protein, albumin, iron, cholesterol, triglyceride, alkaline phosphatase, lactic dehydrogenase (LDH), serum glutamicoxal-acetic transaminase (SGOT), creatinine phosphokinase (CPK), total bilirubin, globulin, and albumin/globilin ratio. Electrolytic balance was also calculated: $Na-(Cl+CO_2)$. Analysis was performed on a SMAC Analyzer (Technicon, Inc., Tarrytown, NY) at Fort Sanders Presbyterian Hospital, Knoxville, TN.

Urinalysis

Urine was collected from immobilized bears by placing a plastic bag in close proximity to the external genitalia and allowing the animal to urinate as a result of relaxed sphincter muscles induced by immobilization drugs. The bladder was also massaged to enhance urine flow. Urine samples were refrigerated for immediate transport to the clinical laboratory for analysis. Bili-labstix diagnostic strips were used to determine pH, protein, glucose, ketones, bilirubin, and occult blood (Ames Co., Elkhart, IN). Specific gravity was determined on a total solids refractometer (American Optical Co., Buffalo, NY). Approximately 10 cc of urine was centrifuged at 3,000 rpm for 3 minutes, the supernatant poured off, and the residue examined microscopically. Cellular tissue and other artifacts were recorded (Davidsohn and Henry 1974).

Infectious Disease Survey

Sera samples were submitted to the C. E. Kord Animal Disease Laboratory, Nashville, TN for serologic titer determinations. Establishment of titer levels was attempted for the following infectious diseases: brucellosis (*Brucella canis* and *abortus*), leptospirosis (serovars canicola, icterohemorrhagiae, pomona, hardjo, and grippotyphosa), pseudorabies, canine distemper, canine parvovirus, and swine parvovirus. The microscopic agglutination test described by Davidsohn and Henry (1974) was used to determine titer levels for the different serovars of *Leptospira*. The mercaptoethanol serial tube dilution test was used to demonstrate agglutinins to *Brucella canis* and *abortus*. The indirect fluorescent antibody test (Davidsohn and Henry 1974) was used to identify the presence of canine distemper virus (CDV), porcine parvovirus, and canine parvovirus antibodies in the bear serum.

Through the cooperation of Dr. Dave Bemis and Dr. Paul Smith, The University of Tennessee College of Veterinary Medicine Departments of Microbiology and Rural Practice, respectively, tests were performed for 3 viral diseases. Attempts were made to nasally culture *Bordetella bronchiseptica* using sterile aluminum shafted Calgiswabs (Fisher Scientific Co., Pittsburgh, PA). Swabs were inserted into the nose and returned to their protective container for refrigerated transport to the laboratory. Ordinary laboratory media was inoculated and incubated at 37°C. Bacterial growths were identified from the media.

The microimmunodiffusion test (MIDT) was used for detecting pseudorabies viral antibodies in a modified approach described by Barbara Perkins (personal communication 1979), Department of Rural Practice. The same test was used to detect antibodies to *B. bronchiseptica*.

Attempts were made to culture swine influenza virus, (A/NJ/8/76), Hsw/N1 and (A/VIC/3/75) H3N2 from bears via nasal and rectal swabs using previously described Calgiswabs (Fisher Scientific Co., Pittsburgh, PA) and sterile dacron swabs. Serologic studies using a hemadsoption inhibition test were used to identify isolates (Davidsohn and Henry 1974, Dr. Virginia Hinshaw, personal communication 1978). Sera samples and culture materials were shipped in a refrigerated container via air express to the St. Jude Children's Research Hospital, Memphis, TN where the laboratory tests were performed.

Post Mortem Examinations

Bears which had been recently killed or incapacitated by vehicle collisions and unintentional management related mortalities were examined in the field and transported to The University of Tennessee College of Veterinary Medicine for tissue analysis and complete post mortem examination. Tissue lesions were examined for histopathological, viral, bacterial and parasitic significance. Diaphragmatic muscle samples were examined for *Trichinella spiralis* larval forms using a tissue digestion technique (Davidsohn and Henry 1974, Soulsby 1968).

Radiologic examinations on carcasses or other anatomical parts were performed at The University of Tennessee College of Veterinary Medicine, Radiology Section, for determining the presence of lead or other artifacts related to illegal hunting activity.

Statistical Evaluation of Data

An Apple II (Apple Computer, Inc., Cupertino, CA) computer equipped with 64 k of RAM memory, with a language card, single disk drive, monitor, and printer was used to prepare, edit, and perform calculations. Calculation of means, standard deviation, range, standard error, and Student's t-distribution was accomplished using 3 prepackaged programs: Statistics with Daisy (Rainbow Computing, Inc., Northridge, CA), The Data Factory (Micro Lab, Highland Park, IL), and Visicalc (Personal Software, Sunnyvale, CA). References for statistical analysis were obtained from Sokal and Rohlf (1981).

CHAPTER IV

RESULTS AND DISCUSSION

A total of 290 bears including carcasses or anatomical parts were included in this study. Two hundred twenty-nine bears were captured live. Fourteen were culvert trapped, 123 were caught in snares, 60 were free ranged immobilized, 29 were barrel trapped, and 3 were immobilized in their winter dens. The remaining 60 bears or carcass remnants had expired. This project began May 1976 and ended September 1980. A summary of bears that were live trapped or free range captured and included in this survey can be found in Appendix A. Hematological parameters are found in Appendix B. Whole blood cell morphological observations are located in Appendix C. Serum biochemical parameters are in Appendix D.

Numerous studies related to conditional evaluation of wildlife exist. Rogers (1976) studied the effects of food availability on survival, growth, and reproductive success of black bears in Minnesota. Dieterich (1970) analyzed hematological values of selected arctic mammals and Franzmann and Leresche (1978) performed blood studies with emphasis on condition evaluation of moose. Vaughn et al. (1973) discussed a disease and conditional blood survey in elk, and chemistry and hematological values were established for elk by Pedersen and Pedersen (1975). Seal et al. (1975) provided detailed ecologic and metabolic interpretations of wolf (*Canis lupus*) pups. Pearson and Halloran (1972) described the hematological profiles of brown bears, and Lee et al. (1977) documented blood values of polar bears. Comprehensive studies of electrolytic relationships of electrolytes, red cells, and plasma were described for polar bear and caribou by Manery et al. (1966), and Nelson et al. (1973) described metabolic changes in bears associated with winter denning periods.

A major objective of this research was not to analyze each hematological and biochemical parameter, but to describe any noticeable pathological observations. Whole blood and its constituents were examined with meticulous attempts to document abnormalities both microscopically and macroscopically.

Hematological Parameters

Hematological parameters were analyzed for 1977 (n=60), 1978 (n=62), and 1979-1980 (n=84). Results were calculated for mean, variance, standard deviation, standard error, minimum value, maximum value, range, and total (Tables 1, 2, and 3). Results were generally similar to those found by Beeman (1981), Erickson and Youatt (1961), King et al. (1960), Matula (1976), and Hamilton (1978). Ages averaged 5.85 in 1977, 3.80 in 1978, and 4.2 in 1979-1980. Weights averaged 61.5 kg in 1977, 54.8 kg in 1978, and 52.25 kg in 1979-1980.

Red blood cell counts were slightly lower in 1979 and 1980 ($6.89 \times 10^3/mm^3$) than in 1977 and 1978 when counts averaged $7.15 \times 10^3/mm^3$ both years. White blood cell counts ($\times 10^3/mm^3$) appeared to average less than Beeman (1981) found, and varied significantly ($P > 0.05$) from 11.67 (1978) to 15.14 in 1977. Hemoglobin values (gm/ml) dropped slightly from 15.45 (1977) and 15.80 (1978) to 14.9 in

Table 1. Hematological parameters for black bears, Smoky Mountains, 1977.

Statistic	Age (Years)	Weight (Lbs.)	White Blood Cell Count ($x10^3mm^3$)	Red Blood Cell Count ($x10^6mm^3$)	Hemoglobin (gm/ml.)	Percent Cell Volume	MCV (μ^3)	MCH ($\mu\mu g$)	MCHC (%)
Mean	5.85	135.50	15.14	7.150	15.45	44.68	65.00	21.59	34.58
Variance	11.98	5742.66	21.10	0.590	3.50	19.90	9.40	1.40	2.90
S.D.	3.46	75.78	4.59	0.774	1.88	4.46	3.06	1.18	1.70
S.E.	0.45	9.78	0.59	0.099	0.24	0.57	0.399	0.15	0.22
Minimum	0.50	23.00	6.00	5.580	12.50	37.50	59.00	19.30	30.71
Maximum	14.50	350.00	27.30	9.020	21.00	54.40	73.00	24.35	38.60
Range	14.00	327.00	21.30	3.440	8.50	16.90	14.00	5.05	7.89
Total	351.00	8132.00	908.50	429.250	926.90	2681.20	3901.00	1295.68	2075.10
N	60	60	60	60	60	60	60	60	60

Table 2. Hematological parameters for black bears, Smoky Mountains, 1978.

Statistic	Age (Years)	Weight (Lbs.)	White Blood Cell Count ($x10^3mm^3$)	Red Blood Cell Count ($x10^6mm^3$)	Hemoglobin (gm/ml)	Percent Cell Volume	MCV (μ^3)	ESR (mm^3/hr)
Mean	3.80	120.93	11.67	7.15	15.80	46.20	65.95	1.31
Variance	7.90	5595.40	16.86	1.70	8.16	70.80	80.80	
S.D.	2.80	74.80	4.10	1.30	2.85	8.40	8.98	
S.E.	0.35	9.50	0.50	0.16	0.36	1.06	1.14	
Minimum	1.00	45.00	2.20	4.60	9.40	28.50	60.00	1.00
Maximum	11.00	500.00	21.60	9.29	19.60	57.00	77.00	2.00
Range	10.00	455.00	19.40	4.69	10.20	28.50	17.00	1.00
Total	236.00	7498.00	723.80	443.31	979.50	2866.00	4089.00	25.00
N	62	62	62	62	62	62	62	19

Table 3. Hematological parameters and morphological observations of whole blood from black bears, Smoky Mountains, 1979-1980.

Statistic	Age (Years)	Weight (Lbs.)	WBC ($x10^3/mm^3$)	RBC ($x10^6/mm^3$)	HGB (gm/ml)	PCV (%)	NSEG (%)	NSTAB (%)	LYMPH (%)	MONO (%)	EOS (%)	BASO (%)
Mean	4.20	115.14	12.50	6.89	14.90	44.1	83.8	2.44	10.30	10.30	4.00	0.003
Variance	11.20	4267.80	42.70	1.64	8.26	75.9	1191.00	13.20	94.10	94.00	28.70	
S.D.	3.30	65.30	6.50	1.28	2.87	8.7	34.50	3.60	9.70	9.70	5.35	
S.E.	0.36	7.00	0.70	0.13	0.30	0.9	3.74	0.39	1.05	1.05	0.58	
Minimum	0.50	10.00	5.60	4.44	8.90	22.0	46.00	0.00	1.00	0.00	0.00	0.00
Maximum	14.00	350.00	48.90	9.12	21.40	58.0	93.00	18.00	35.00	35.00	22.00	2.00
Range	13.50	340.00	43.30	9.12	12.50	36.0	47.00	18.00	34.00	35.00	22.00	2.00
Total	357.00	9787.00	1068.00	586.40	1269.00	3745.00	4575.00	208.00	876.00	340.00	240.00	2.00
N	84	84	84	84	84	84	64	64	64	64	64	64

1979-1980. Percent cell volumes (PCV), mean corpuscular hemoglobins ($\mu\mu^3$), mean corpuscular volumes (μ^3) and mean corpuscular hemoglobin concentrations (%) did not differ between years.

Estimated sedimentation rates (ESR) of whole blood consistently produced similar results, probably due to the decreased mobility of erythrocytes which had been refrigerated and a delay in testing. Sedimentation rates can be increased due to pregnancy, infection, metabolic disorders, cardiac disorders, and numerous other inflammatory processes. An accelerated ESR is favored by elevated levels of fibrinogen and globulin. Anemia can change the erythrocyte-plasma ratios, favoring increased settling of cells (Davidsohn and Nelson 1974). Ideally, the test should be run within 2 hours of blood collection. Erythrocytes tend to become more spherical and less inclined to settle out with increases in time out of the body (Davidsohn and Nelson 1974). The average estimated sedimentation rate was 1.31 mm/hour. Evaluation of viscosity of whole blood must be determined under controlled laboratory conditions in order to determine the usefulness of the sedimentation rate (Halikas and Bowers 1972).

Morphological Observations of Whole Blood

Stained blood smears furnished an excellent approach for studying the morphology of the blood and blood parasites. Red blood cells were examined for irregularities in hemoglobin concentration, prematurity, inclusion bodies, structural integrity, and intracellular inclusions of parasitic origin. Fifty-nine blood smears were examined in 1977. Most of the cells appeared to be typical, with only minor disruptions in cell size, integrity, and hemoglobin concentration.

In the entire sample group (n=185), reticular remnants known as Howell-Jolly bodies were observed in smears from 8 bears of varying ages and both sexes. The absence of any cellular irregularities seemed remarkable considering the size and diversity of the sampled population. Most erythrocytes appeared to be normochromic, normocytic, and slightly anisocytic.

Leucocytes were differentially counted, observed for toxic granulation, maturation, inclusion bodies, and other cellular pathology. A total of 185 smears were examined for differential evaluation. A ratio of approximately 80 neutrophils:10 lymphocytes:10 miscellaneous types was observed for all 4 years (Tables 3, 4, and 5). Consistently the leucocytes appeared to be mature, without noticeable cellular inclusions, and within ranges previously described (Beeman 1981, Hock 1966, Matula 1976, Seal et al. 1967, Svihla et al. 1955, and Youatt and Erickson 1958). Slight eosinophilia (> 10 eosinophils/ 100 wbc counted) was noted in 12 bears which may be related to allergenic response or parasitism.

Reticulocytes, newly arrived erytrocytes in the peripheral circulation, are indicators of the erythropoietic status of blood. Reticulocytes are differentially stained with new methylene blue and counted per 1,000 mature red blood cells (Davidsohn and Nelson 1974). Reticulocytic values were determined for 26 bears (Table 5). The mean value was 0.08/100 rbc. No other values were available for comparison from wild black bears.

Thrombocytes or platelets function in supporting the endothelium of blood vessels by plugging up leaks and maintaining a primary role in

Table 4. Morphological observations of whole blood from black bears, Smoky Mountains, 1977.

Statistic	Age (Years)	Weight (Lbs.)	Neutrophils (Seg.) (%)	Neutrophils (Stab.) (%)	Lymphocytes (%)	Monocytes (%)	Eosinophil (%)	Basophil (%)	Platelet Count ($x10^3mm^3$)
Mean	5.85	135.50	82.85	2.90	9.560	1.78	1.15	0.005	192.00
Variance	11.98	5742.66	189.80	12.16	41.470	3.73	3.99		42879.30
S.D.	3.46	75.78	13.77	3.48	6.439	1.93	1.99		207.07
S.E.	0.45	9.78	1.77	0.45	0.831	0.25	0.25		26.29
Minimum	0.50	23.00	55.00	0.00	1.00	0.00	0.00	0.00	164.00
Maximum	14.50	350.00	99.00	16.00	26.00	8.00	13.00	2.00	624.00
Range	14.00	327.00	44.00	16.00	25.00	8.00	13.00	3.00	460.00
Total	351.00	8132.00	4971.00	174.00	574.00	107.00	69.00	3.00	119040.00
N	60	60	59	59	59	59	59	59	32

Table 5. Morphological observations of whole blood from black bears, Smoky Mountains, 1978.

Statistic	Age (Years)	Weight (Lbs.)	Neutrophils (Seg.) (%)	Neutrophils (Stab.) (%)	Lymphocytes (%)	Monocytes (%)	Eosinophil (%)	Reticulocyte (% 100 RBC)
Mean	3.80	120.93	81.59	0.87	11.95	0.83	1.46	0.08
Variance	7.90	5595.40	328.20	1.26	64.30	0.98	16.70	0.01
S.D.	2.80	74.80	18.10	1.23	8.01	0.99	4.00	0.13
S.E.	0.35	9.50	2.30	0.14	1.00	0.12	0.52	.01
Minimum	1.00	45.00	52.00	0.00	1.00	0.00	0.00	0.00
Maximum	11.00	500.00	98.00	5.00	33.00	3.00	29.00	0.50
Range	10.00	455.00	46.00	5.00	32.00	3.00	29.00	0.50
Total	236.00	7498.00	5059.00	54.00	741.00	52.00	91.00	4.98
N	62	62	62	62	62	62	62	26

hemostasis. Platelet counts are highly variable in normal individuals (Davidsohn and Nelson 1974). Platelet counts were performed on 32 bear blood samples (Table 4). The mean was 192 x $10^3/mm^3$, lower than the mean determined (5.33 x $10^3/mm^3$) by Beeman (1981).

Urinalysis

Urine values are noticeably lacking for free ranging wildlife. Hoff et al. (1976) collected urine from gray squirrels and tabulated the results. Partial urinalysis was made from 4 adult bears (3 wild and 1 captive) by King et al. (1960). With the use of immobilization agents which cause muscle relaxation, enhancing urine production, urine specimens were collected from 8 bears in sealable plastic bags. Routinely performed urine values were determined (Table 6). Both males (n=4) and females (n=4) ranging in age from 0.5 to 12.5 were sampled. Weights ranged from 6.81 to 147.5 kg. Specific gravity values ranged from 1.004 to 1.017. Urinary pH values ranged from 5.5 to 8.0. No trace of protein, glucose, ketones, bilirubin or urobilinogen was detected. Occult blood was found ranging from 0 to 4+. The cause for the high amount of blood was not determined. Microscopic observations revealed the presence of leucocytes in 7 bear urine specimens (Table 7). Five urine samples contained low numbers of erythrocytes and epithelial cells. Cellular observations were determined by the number of cells observed in 10 oil immersion fields. Spermatozoa was observed in the urine of 2 males. Large numbers of triple phosphate crystals were noted in a sample from a female cub. Budding yeast was seen in urine from a yearling female. The

Table 6. Urinalysis for black bears, Smoky Mountains, 1979-1980.

Bear	Date	Sex	Age (Years)	Weight (Lbs.)	Specific Gravity	pH	Protein	Glucose	Ketones	Bilirubin	Hemoglobin	Urobilinogen
549	08/21/79	F	12.0	150	1.004	6.0	0	0	0	0	1+	0
586	10/16/79	M	3.0	175	1.013	6.0	0	0	0	0	0	0
590	10/22/79	F	6.0	122	1.005	8.0	0	0	0	0	4+	0
589	10/27/79	F	0.5	15	1.017	8.0	0	0	0	0	0	0
622	06/09/80	F	1.0	65	1.004	5.5	0	0	0	0	4+	0
626	08/05/80	M	2.5	105	1.007	6.0	0	0	0	0	0	0
621	08/07/80	M	12.5	325	1.004	6.0	0	0	0	0	3+	0
625	08/08/80	M	3.5	135	1.006	6.0	0	0	0	0	1+	0

Table 7. Microscopic observations of urine from black bears, Smoky Mountains, 1979-1980.

Bear	Date	Sex	Age (Years)	Weight (Lbs.)	WBC	RBC	EPITH	CELLS	Comments
549	08/21/79	F	12.0	150	0	0	0		Clear yellow
586	10/16/79	M	3.0	175	100	2-4	5-8	Renal	WBC clumps, bacteria
590	10/22/79	F	6.0	122	0-2	25	0-2		MOD amorphous material
589	10/27/79	F	0.5	15	0-1	0-1	0-2		4+ triple phos crystals
622	06/09/80	F	1.0	65	1-4	0	0		Budding yeast
626	08/05/80	M	2.5	105	0-1	0	0-3		Amorphous material
621	08/07/80	M	12.5	325	1-4	0-2	0		4+ sperm, amorphous mat
625	08/08/80	M	3.5	135	0-2	0-2	0-2	Bladder	4+ sperm

observation of 100 wbc per oil immersion field suggested a urinary tract infection in a 3 year old male. The urine observations were not considered to be unusual. No other urinalysis values were available for comparison from wild black bears. Methods used for testing and evaluation are described by Bradley and Benson (1974).

Serum Biochemical Parameters

Twenty-four biochemical parameters were determined for 130 bears. The accumulated results must be qualified by emphasizing the values were obtained from highly stressed animals injected with a variety of immobilization agents, and blood collection procedures were not uniform. Transportation of specimens to laboratory facilities was usually accomplished within 6 hours. Separation of sera was often delayed for periods up to 24 hours. The importance of quality controls throughout the collection and processing of sera has been repeatedly emphasized for accurate determination of liver function studies by Routh (1976), for general chemical parameter processing (Tietz 1976, Cohn and Kaplan 1966), and very sensitive for enzyme determinations (Kachmar and Moss 1976). Certain plasma proteins are heat sensitive but are fairly resilient to slight environmental stresses (Dimopoullos 1970).

Beeman and Pelton (1979) described associations between immobilization drugs and blood parameters. Problems associated with analyzing blood parameters from wildlife have been discussed by Halloran and Pearson (1972) in brown bears (Ursus arctos), Johnson et al. (1968) in white-tailed deer, Seal and Erickson (1969) in white-tailed deer, Seal et al. (1972) and in European wild hogs by Williamson (1972).

Results (Tables 8 and 9) were similar to those found by Beeman (1981) in the following determinations: chloride, calcium, phosphorus, creatinine, uric acid, billirubin, and carbon dioxide. Sodium, BUN, glucose, total protein, albumin, alkaline phosphatase, and SGOT levels were notably lower. Glucose levels considered too low to be compatible with metabolic functions (< 50.0 mg/dl) were erroneously produced as a result of collection irregularities, inaccurate analysis, or a combination of both. CPK levels were much lower, differing by 444 U/L from an average of 641.2 determined by Beeman to 197.7 in this study. Several levels were higher including potassium, iron, cholesterol, and triglycerides. Differences in the results may have been due to capture, handling, blood collection and sera preparation techniques.

Infectious Diseases

Leptospira interrogans. Antibody titers for 5 serovars of Leptospira were determined from sera samples from 240 bears. Leptospirosis is caused by antigenically distinct serovarieties that may impair the health of wildlife. Some species are epidemiologically important because they may serve as a source of infection for other species, including man, and domestic animals (Shotts 1981).

Leptospirae are the smallest spirochetes. Although indistinguishable on the basis of morphological, cultural, and biochemical characteristics, pathogenic leptospira are differentiated by their

Table 8. Serum biochemical parameters for black bears, Smoky Mountains, 1978-1979.

Statistic	Glucose (mg/dl)	Bun (mg/dl)	Creatinine (mg/dl)	NA (mEg/L)	K (mEg/L)	CL (mEg/L)	CO2 (mEg/L)	Uric Acid (mg/dl)	CA (mg/dl)	P (mg/dl)	Bun/ Creatinine	Electrolyte Balance
Mean	72.30	8.60	1.430	130.800	5.64	99.40	20.10	2.140	7.71	5.70	6.00	20.7
Variance	2579.00	62.60	0.88	1477.000	1.64	301.50	22.80	0.790	1.68	4.86	30.30	33.0
S.D.	50.80	7.91	0.94	38.400	1.28	17.30	4.78	0.890	1.29	2.20	5.50	5.74
S.E.	4.43	0.69	0.08	3.357	0.11	1.51	0.41	0.077	0.11	0.19	0.48	0.50
Minimum	0.00	0.00	0.70	100.000	3.00	70.00	8.00	0.800	5.30	2.40	0.00	0.00
Maximum	211.00	45.00	11.20	158.000	9.70	129.00	32.00	5.400	11.00	10.00	25.00	36.00
Range	211.00	45.00	10.50	58.000	6.70	59.00	24.00	4.600	5.70	7.60	25.00	36.00
Total	9469.00	1129.00	188.40	17141.000	739.60	13027.00	2639.00	280.800	1011.00	747.20	798.30	2714.00
N	127	119	129	121	129	128	129	129	129	125	119	129

Table 9. Serum biochemical parameters for black bears, Smoky Mountains, 1978-1979.

Statistic	Protein (g/dl)	ALB (g/dl)	FE (mcg/dl)	CHOL (mg/dl)	TRIG (mg/dl)	8ILI (mg/dl)	ALK. PHOS. (U/L)	LOH (U/L)	SGOT (U/L)	CPK (U/L)	Globulin	A/G
Mean	6.97	3.68	217.20	265.4	234.70	0.16	43.07	57.70	126.9	197.7	3.20	1.14
Variance	0.80	0.31	10790.00	3464.0	6865.00	0.02	466.90	24793.00	13765.0	61977.0	0.35	0.06
S.D.	0.89	0.56	103.90	58.8	82.80	0.13	21.60	157.50	117.3	248.9	0.59	0.25
S.E.	0.08	0.04	9.14	5.1	7.29	0.01	1.90	13.86	10.3	21.9	0.05	0.02
Minimum	4.80	2.30	55.00	138.0	81.00	0.00	10.00	251.00	27.0	12.0	2.00	13.00
Maximum	9.60	5.70	651.00	445.0	499.00	1.00	120.00	579.00	466.0	947.0	5.00	1.80
Range	4.80	3.40	596.00	307.0	418.00	1.00	110.00	328.00	439.0	935.0	3.00	1.67
Total	899.70	475.80	28021.00	34240.0	30282.00	21.20	5557.00	7456.00	16371.0	25511.0	424.40	147.00
N	129	129	129	129	127	128	129	16	108	93	129	129

serological properties. Leptospira are divided into serovars because of their serologic responses. Twenty-five serovars have been isolated in a variety of North American wildlife (Shotts 1981).

Infective urine is the major source of infection for susceptible wild mammals (Shotts 1981). Urine containing large numbers of leptospires is usually involved indirectly or directly in the transmission of leptospirosis. Environmental conditions that favor the survival of leptospiral organisms include moist, slightly alkaline soils, stagnant pools of water, and slow moving alkaline streams (Bruner and Gillespie 1973).

The leptospires enter a host through mucous membranes or broken skin. Antibodies appear about the tenth day after infection and peak about the second or third week. Antibody titers can persist for months or years. Serologic tests which are not indicative of infection should be interpreted as a valuable aid to diagnosis of leptospirosis, especially when significant titer increases are documented (Bruner and Gillespie 1973).

Leptospirosis is not a particularly serious disease for humans and is probably one of the most common infectious diseases of wildlife in North America (Shotts 1981). Although not considered as a health problem in zoo bears (Wallach 1978), leptospirosis has been described in zoo workers associated with bears (Anderson et al. 1978).

It has not been established whether acute leptospirosis which often can be fatal, occurs regularly among wild mammals. Most studies suggest wild mammals have a role in the maintenance of the disease and its transmission to man and domestic animals (Shotts 1981). Where chronic infection rate is high, the mortality rate is assumed to be low. The prevalence of chronic infection is inversely proportional to the mortality rate. If the prevalence of chronic infection is high in a population, the immunity produced is not of significant magnitude for the host to completely rid itself of the organism (Andrews and Ferris 1966, Shotts 1981).

From data collected on bears, leptospirosis appears to have achieved a symbiotic state associated with chronic infection and unobserved associated mortality (Table 10). A total of 64 bears, including 42 males and 22 females, were reactors (> 1:50) for 5 serovars of L. interrogans representing 26.6% of the total population tested. If weights are indicative of condition, reactors were in similar weight categories as non-reactors. The average age for the entire population (4.6) was similar to the reactor population (4.84).

Fifteen reactors, including 10 males and 5 females were found for canicola. The only reactor for hardjo was a male. Pomona was determined to be associated with adult females with 8 of 10 reactors of that gender. Both reactors for grippotyphosa were males. Thirty-six reactors, including 21 males and 15 females were determined for icterohemorrhagiae. Nine bears were reactors to two different serovars. One bear was a reactor for canicola and hardjo, 6 bears were reactors to pomona and icterohemorrhagiae, and 2 bears were reactors to canicola and icterohemorrhagiae (Appendix E).

Capture methods tended to favor adults (Johnson and Pelton 1980a), reducing the availability of young bears for the survey. Capture periodicity was limited to late spring until fall, establishing

Table 10. *Leptospira* serovar survey for black bears, Smoky Mountains, 1976-1980.

Population	Canicola	Hardjo	Pomona	Grippotyphosa	Icterohemorrhagiae
Total tested	240	240	240.00	240	240
No. reactors	15	1	10.00	2	36
% total pop.	6.25	0.416	4.16	0.833	15.0
No. + males	10	1	2	2	21
No. + females	5	0	8	0	15
Age range	1.0-9.5	5.0	2.0-8.0	1.0-3.0	0.5-12.0
Ave. weights	142.80	155.0	139.60	85.0	140.9

a 6 month interval for testing. Spatial features indicated an even distribution pattern for canicola, pomona, and icterohemorrhagiae throughout the study area along established trapline study areas.

Brucellosis. An infectious disease associated with several antigenically distinct bacteria, brucellosis occurs in a wide variety of mammals in North America. Usually the infection begins as a bacteremia without clinical signs and subsequently localizes in the lymph nodes, spleen, reproductive tract, muscles, joints, and other organs where it persists for extended periods (Witter 1981).

Brucella canis, a serotype most notably associated with pen-raised dogs, and *B. abortus*, usually associated with domestic farm stock, were the 2 pathogens chosen to be evaluated. *B. suis* was not available from the laboratory. Serologic detection of antibodies to *B. canis* was attempted in 240 sera samples. No reactors were found. Antibody titers to *B. abortus* were examined for 67 sera samples. No reactors were found.

Canine distemper virus and canine parvovirus. An acute or subacute febrile disease of many species of the order Carnivora, distemper is caused by a single antigenic type virus known as the virus of Carre. CDV may be indicated by signs of generalized infection, hyperkeratosis, central nervous system disturbances, or any combination of these (Budd 1981). Morbidity and mortality rates vary among species but may be extremely high in susceptible populations. Aerosol or direct contact are the presumed methods of natural transmission. Nasal and conjunctival exudates, urine, and feces can contain CDV. Bloodsucking arthropods have been suggested as vectors. Little is known of the epizootiology of CDV in wildlife populations (Budd 1981).

One hundred forty bears were tested serologically for CDV. Fifty-two reactors (29.2%), including 32 males and 20 females were detected (Appendix F). Ages of reactors ranged from 0.5 to 12.0. Weights of the reactor group averaged 66.0 kg, significantly greater ($P > 0.05$) than the average weights of the sampled population (56.2 kg). Males appeared to be significantly favored ($P > 0.05$) more than females. No reactors were found in the 1977 sample group but 27 reactors were determined for 1978 and 25 for 1979. Periods of captures of reactors extended from 19 June 1978 until 10 September 1978 and from 17 May 1979 until 4 September 1979. The distribution of the reactors was throughout the study area with no obvious concentrations.

Keeler (1978) reported an epizootic of canine distemper in the raccoon (Procyon lotor) population in Cades Cove from March 1973 until March 1974. The population declined 63%. Corresponding decreases in the bear population have not been observed.

A canine parvovirus outbreak was first reported in dogs in the eastern United States in 1978 and reached epidemic levels in May and June 1980; the major laboratory finding was marked leukopenia in dogs (Center for Disease Control 1980). Sixty sera samples collected during the 1978 and 1979 collection period did not contain antibodies for canine parvovirus. Leucocyte counts were decreased in 1978 to 11.67 x 10^3 mm^3 but increased slightly in 1979 to 12.5 x 10^3 mm^3. In 1977 the mean WBC was 15.14 x 10^3 mm^3. The specific cause of the transient leukopenia in bears was not determined.

Infectious bovine rhinotracheitis and atrophic rhinitis. A respiratory disease, infectious bovine rhinotracheitis (IBR), is caused by an antigenically homogenous DNA virus. The disease is normally associated with cattle (Bruner and Gillespie 1973). Sixty-seven sera samples were submitted for testing for antibody titers. All specimens were collected during the 1978 to 1979 period; no serologic reactors were found.

Attempts were made to culture *Bordetella bronchiseptica*, a bacterial organism believed to be associated with atrophic rhinitis, from 42 nasal swab specimens collected during 1978 and 1979. Fifty sera samples were tested for *Bordetella*, sp. antibodies; no reactors were found and all cultures were negative.

Swine parvovirus, pseudorabies, and swine influenza. Parvoviruses are single stranded DNA viruses that usually cause acute febrile episodes and appear to be highly contagious. Direct contact with infected feces, urine, saliva, and vomitus is the usual mode of transmission (Davis et al. 1981). Sixty-seven sera samples collected in 1978 and 1979 were negative for antibodies to swine parvovirus.

Pseudorabies or Aujeszky's disease is an infectious herpesvirus disease that infects the central nervous system of wild and domestic mammals. It is an acute disorder usually causing fatal termination. Very little is known about the pathogenesis of the disease in wildlife

(Trainer 1981). Sixty-seven sera samples were tested for antibody titers and no reactors were found.

An acute disease of the respiratory tract, swine influenza is often associated with rapidly appearing epidemics of relatively short duration. The disease is caused by an orthomyxovirus and is usually limited to swine. Attempts were made to culture swine influenza virus, (A/NJ/8/76), Hsw/N1 and (A/VIC/3/75) H3N2 from 42 bears via nasal and rectal swabs. All cultures were negative. Forty-two sera samples were tested for antibodies to swine influenza but were negative. Samples were collected during 1978 and 1979.

Parasitic Diseases

Dirofilaria ursi. While examining stained whole blood smears, microfilariae morphologically similar to the nematode, *Dirofilaria immitis*, or dog heartworm, were observed (Figs. 2 and 3). Microfilariae had similar measurements of length (256 μm) and width (5.0 μm) given for *Dirofilaria ursi* as reported by Addison (1976), Addison et al. (in press) and Anderson (1952). *Dirofilaria ursi* had been reported in the black bear in the southeast United States by Cook and Pelton (1979), Crum (1977), and Crum et al. (1978). Hamilton (1978) and Juniper (1978) had described *D. immitis* in bears and suggested the *Diptera*, sp. mosquitoes were vectors for *D. ursi*. The pathological influence of *D. ursi* is believed to be insignificant, unlike the effect of *D. immitis* in dogs (Addison 1976).

A total of 205 whole blood samples were examined for microfilariae. One hundred sixty-eight (81.9%) of the samples contained

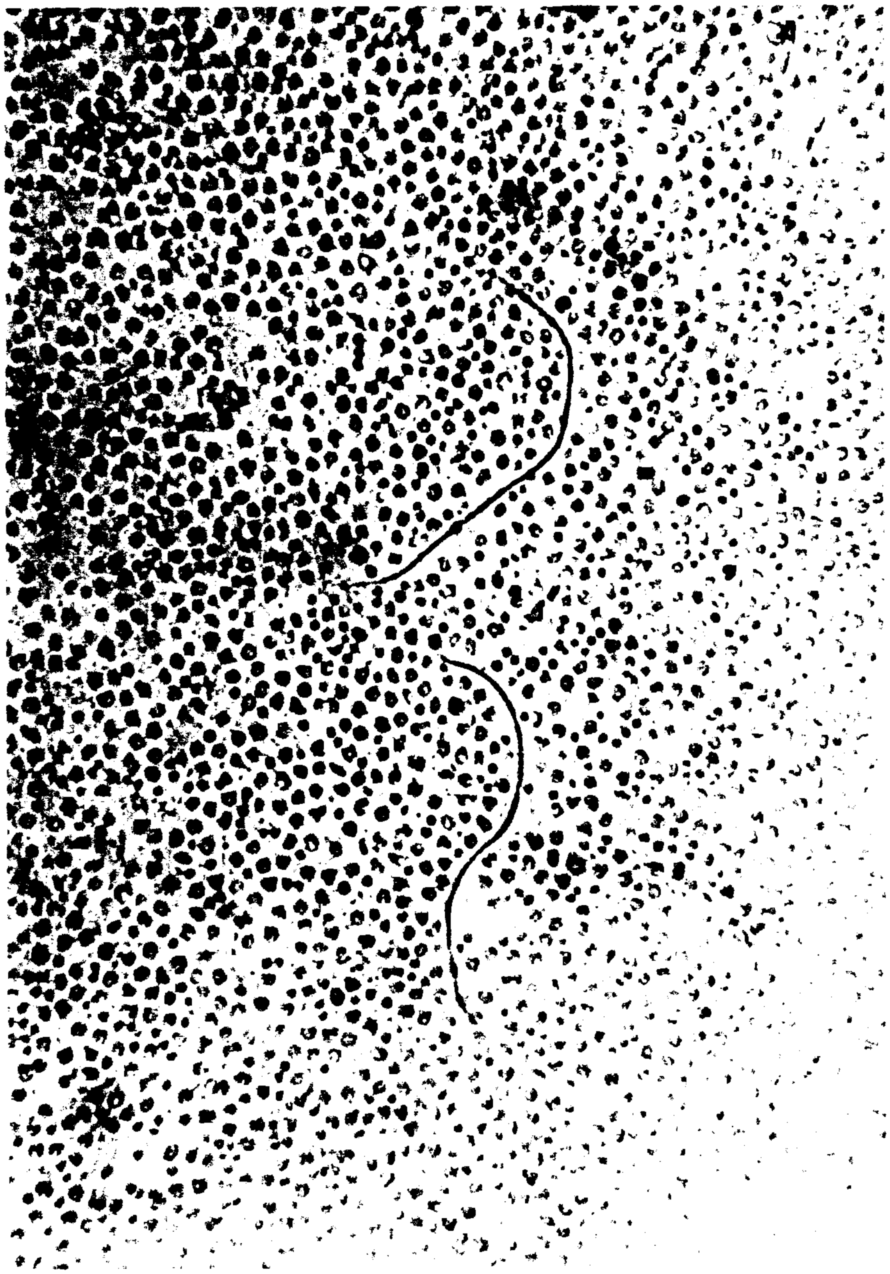

Fig. 2. Microfilariae of Dirofilaria ursi in unstained whole blood (x100).

Fig. 3. Microfilariae of Dirofilaria ursi in stained whole blood (x450), measures 251 μm x 5.2 μm.

this parasite. All age classes (0.5-12.5), sizes (4.54 kg-227 kg), and both sexes were infected. Periodicity of collection from May until October provided samples with microfilariae. Bears from all areas of the study were also infected. The parasite was very commonly observed in the blood smears (Figures 2 and 3).

Trichinella spiralis. Another nematode often found in bears, Trichinella spiralis can cause serious disease problems and may be fatal (Zimmermann 1971). Trichinosis results from larval forms invading the musculature of carnivorous and omnivorous host species. Trichinosis has been documented in bears in Arizona (LeCount 1981), northwestern Alberta (Dies 1979), central Ontario (Addison et al. in press), and British Columbia (Bowmer 1973). In a survey for trichinosis in the southeastern United States, Crum (1977) was unable to recover larvae from 53 bears examined.

Diaphragm specimens from 10 bears were digested (Davidsohn and Henry 1974) and the resulting suspension was searched for larvae. No larvae were observed during microscopic examination.

Post Mortem Examinations

Availability and accuracy of reported information limited the number of animals that were assessed using post mortem techniques similar to those described by King et al. (1960). The processing of case incident records was changed in 1978 when GSMNP began systematically recording pertinent information pertaining to bear mortalities in the Park. No carcasses were examined from the Tellico Wildlife Management Area, Cherokee National Forest, Tennessee. Park personnel were required to report immediately the carcass or any carcass parts to Resource Management for complete evaluation and disposal (U.S. Department of the Interior 1978).

Investigations included a thorough search of the carcass scene, recovery of the carcass when available, photographic documentation (Fig. 4), and extensive post mortem examination when possible. Post mortem examinations were performed to determine cause of death and extent of injuries (Fig. 5). Radiologic techniques were used when appropriate (Fig. 6).

Four bears, including 3 males and 1 female, were determined to have died from injuries associated with vehicle collisions. Two bears, a male and female were euthanized after they received debilitating injuries as the result of vehicle accidents. Five bears, 4 males and 1 female, that were free range captured in front country areas were discovered to have non-debilitating wounds that had been inflicted by firearms. Two female cubs that were classified as accidental management kills were necropsied. Twenty-eight carcasses or carcass remnants were radiologically examined and determined to have died as the result of gunshot wounds. The remaining 12 carcasses were examined and determined to have been forcibly separated or cut from other portions of carcasses.

Post mortem decomposition was the most frequently encountered obstacle to successful evaluation for Ascaris, sp., lung worms, and gastro-intestinal parasites. No parasites or evidence of lesions were observed in respiratory and gastro-intestinal systems of 15 bears examined. Six front country panhandling (Tate and Pelton 1980) bears

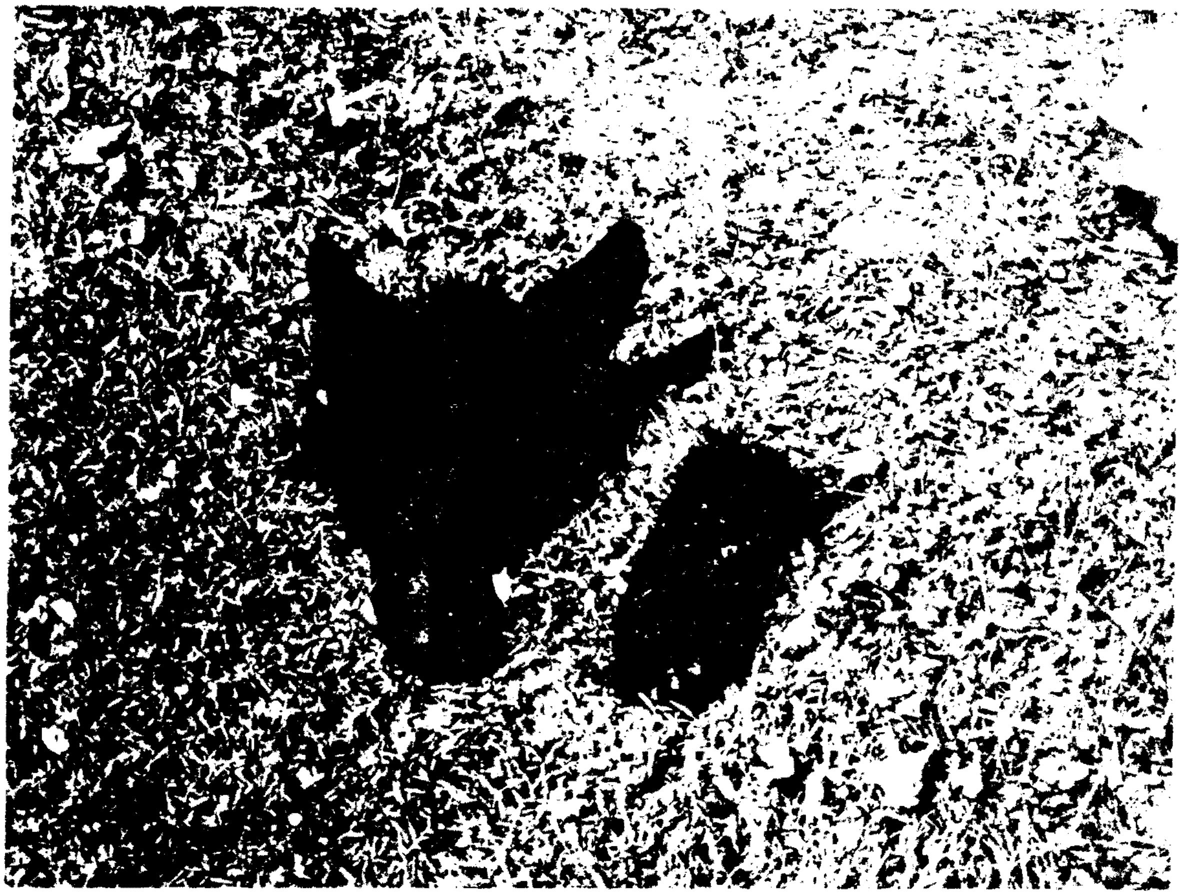

Fig. 4. Decapitated black bear head and paw; the bear illegally killed in the Great Smoky Mountains National Park, 1978.

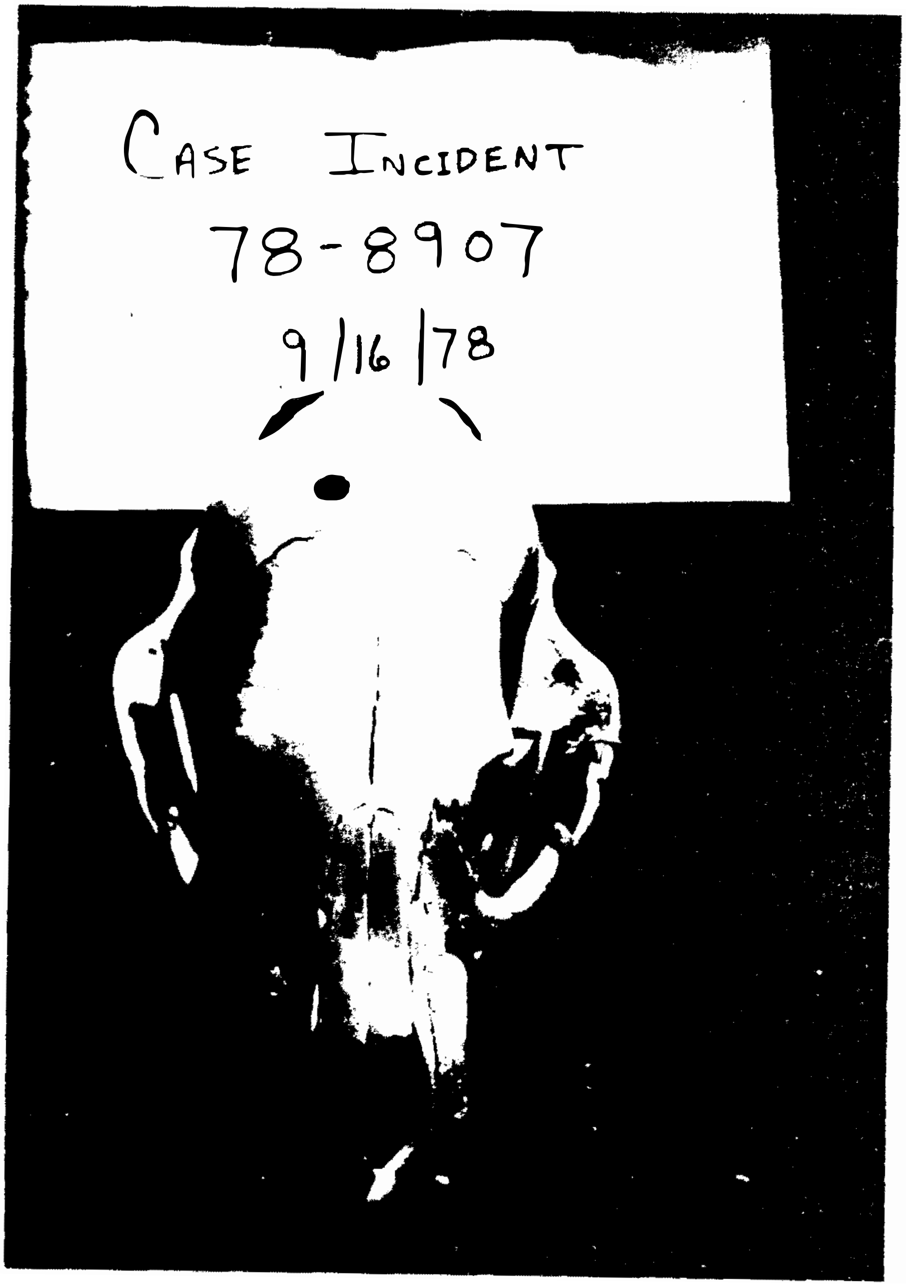

Fig. 5. Skull of decapitated black bear with bullet wound; illegally killed in the Great Smoky Mountains National Park, 1978.

Fig. 6. Radiograph of skull showing lead bullet; illegally killed black bear from the Great Smoky Mountains National Park, 1978.

had food items including meat scraps, meat package wrappers, aluminum foil, and corn and potato chip wrappers in their gastrointestinal tracts. Kidneys were examined in 5 bears, but no lesions were observed. Fecal flotations were performed to attempt to recover eggs or oocysts from 12 carcasses. No eggs or oocysts were recovered.

Thorough post mortem examination procedures provided information not otherwise available concerning mortality factors associated with bears. The documentation of observations determining illegal hunting techniques and spatial and temporal aspects of illegal hunting activity should be helpful to resource managers in the Park.

CHAPTER V

SUMMARY AND CONCLUSIONS

1. Research was conducted in the northwestern portion of the Great Smoky Mountains National Park and the Tellico Wildlife Management Area from May 1976 through September 1980 to accumulate information related to the pathology of black bears.

2. A total of 290 bears including carcasses or anatomical parts were included in this survey. Pathological observations and their epidemiological implications were discussed.

3. Hematological parameters were tabulated and found to be very similar to previous descriptive information.

4. Red blood cell counts were slightly lower in 1979 and 1980 than in 1977 and 1978.

5. White blood cell counts were found to be less than previously described but maintained an overlapping range of normality for the population surveyed.

6. Hemoglobin, packed cell volume, mean corpuscular hemoglobin, mean corpuscular volume, and mean corpuscular hemoglobin concentration values did not differ between years.

7. Estimated sedimentation rates of whole blood were not collected and analyzed within acceptable time constraints to be considered valid. The average sedimentation rate was 1.31 mm/hour.

8. Stained blood smears furnished an excellent opportunity to study the morphology of the blood and blood parasites.

9. One hundred eighty-five blood smears were analyzed for erythrocytic irregularities in hemoglobin concentration, prematurity, inclusion bodies, structural integrity, and other abnormalities. Most erythrocytes appeared to be normochromic, normocytic, and slightly anisocytic. No cellular irregularities were observed that were significantly apparent.

10. Consistently leucocytes appeared to be mature, without noticeable cellular inclusions, and within differential ranges previously described.

11. Reticulocyte values were determined for 26 bears. The mean value was 0.08/100 red blood cells counted. This is the first known study to determine reticulocyte values in wild black bears.

12. Platelet counts were performed on 32 samples. The mean was 192 x $10^3/mm^3$. Counts were similar to those reported earlier.

13. Urine biochemical and morphological observations were made on 8 specimens. Values were similar to those expected except for accumulations of leucocytes and triple phosphate crystals in 2 different specimens. Occult blood values were higher than expected.

14. Twenty-four biochemical parameters were determined for 130 bear sera samples. Results were similar to those described previously with the exception of CPK levels which were much lower and may be stress related.

15. Antibody titers for 5 serovars of <u>Leptospira interrogans</u> were determined from 240 sera samples. A total of 64 bears were reactors for at least 1 of the 5 serovars. Fifteen reactors, including 10 males and 5 females were found for canicola. Only 1 male

reactor was determined for hardjo. Pomona was associated with 8 females and 2 males. Both grippotyphosa reactors were male. Thirty-six bears, including 21 males and 15 females presented titers for icterohemorrhagiae. Nine bears were reactors for two different serovars.

16. Leptospirosis appears to be currently active but its impact on the population is not excessive.

17. There were no antibody titers detected for Brucella canis (n=240) and abortus (n=67).

18. One hundred forty bears were serologically tested for canine distemper virus antibodies. Fifty-two reactors (29.2%), including 32 males and 20 females were detected. Because the disease can produce relatively high mortality and morbidity rates, the significance of the antibody titers in bears is cause for concern. Very little is known about the epizootiology of CDV in wildlife populations. Periodic serologic surveys for CDV in bears is recommended.

19. There was no evidence of infectious bovine rhinotracheitis, atrophic rhinitis, and Bordetella bronchiseptica antibodies. Attempts to culture B. bronchiseptica were futile.

20. Evidence of canine and porcine parvovirus, pseudorabies, and swine influenza were not detected serologically in the bears sampled.

21. A total of 205 whole blood samples were examined for microfilaria of Dirofilaria ursi. Eighty-one percent (n=168) of the bears sampled were carrying this larval form. The pathological influence of D. ursi is believed to be minimal.

22. *Tricinella spiralis* larvae were not found in a very small sample size (n=10).

23. Limited information related to infectious and parasitic diseases was obtained by the post mortem examination of 25 bears.

24. Twenty-eight carcasses were found to have been illegally shot. Radiologic examination of carcasses was discovered to be an excellent diagnostic aid for detection of lead projectiles in bears.

25. The bear population in the Smoky Mountains appears to be in good condition based on the hematologic, biochemical, infectious and parasitic disease observations made in this study.

26. Periodic serologic surveys of black bears are recommended for infectious diseases that are reported to be epizootic in domestic animals in the southeastern United States and potentially transmissible.

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APPENDICES

APPENDIX A

BLACK BEAR CAPTURES 1977-80

BEAR	INDEX	DATE	LOCATION	TIME	SEX	AGE	WT	CAPT TECH	CONDITION
P-1	172-01	06/01/77	Chimneys	1245	M	2.5	100	Culvert	Fair
91	173-01	06/12/77	Tremont	1120	M	10.5	220	Snare	Excellent
0-10	094-02	06/14/77	Tremont	1145	M	10.5	210	Snare	Good
0-11	174-01	06/16/77	Bote Mt.	1120	M	3.5	105	Snare	Poor
0-13	093-02	06/19/77	Bote Mt.	1100	M	5.5	152	Snare	Good
0-14	130-02	06/19/77	Bote Mt.	1230	M	9.5	250	Snare	Collar wound
0-15	175-01	06/20/77	Bote Mt.	0955	M	6.5	180	Snare	Good
0-16	176-01	06/21/77	Bote Mt.	0945	F	8.5	147	Snare	Good
93	177-01	06/22/77	Cades Cove	1618	M	1.5	70	Free-range	Fair
P-2	178-01	06/23/77	Cades Cove	1440	M	1.5	70	Free-range	Good
F-4	164-02	06/27/77	Sugarland Mt.	1050	M	6.5	210	Snare	Open wound
F-10	179-01	06/28/77	Sugarland Mt.	1045	M	9.5	350	Snare	Excellent
E-7	060/02	06/29/77	Bunker	1225	F	14.5	110	Snare	Good
C-5	148-02	06/29/77	Parsons Br.	0920	M	5.5	145	Snare	Good
F-5	097-03	06/29/77	Sugarland Mt.	0945	F	8.5	110	Snare	Good
P-1	172-02	06/30/77	Cades Cove	1720	M	12.0	105	Culvert	Good
F-21	180-01	06/30/77	Sugarland Mt.	1145	F	3.5	62	Snare	Open wound
E-60	182-01	07/02/77	Bunker	1225	F	6.5	100	Snare	Fair
E-8	181-01	07/02/77	Bunker	1100	M	3.5	80	Snare	Fair
E-23	183-01	07/03/77	Parsons Br.	0940	M	6.5	200	Snare	Good
E-24	185-01	07/03/77	Bunker	1230	M	2.5	55	Snare	Fair
F-13	184-01	07/03/77	Sugarland Mt.	1110	F	11.5	105	Snare	Poor
P-3	186-01	07/11/77	US 441	1118	F	2.5	80	Free-range	Fair
C-10	159-02	07/22/77	Rabbit Crk.	1150	M	4.5	137	Snare	Poor
B-10	187-01	07/22/77	Tremont	0930	F	6.5	90	Snare	Poor
B-15	192-01	07/24/77	Bote Mt.	1105	M	9.5	160	Snare	Fair
C-2	144-04	07/26/77	Rabbit Crk.	0957	M	8.5	310	Snare	Excellent
B-17	195-01	07/28/77	Tremont	0925	F	6.5	85	Snare	Poor
C-22	194-01	07/28/77	Rabbit Crk.	1000	F	6.5	115	Snare	Poor
B-16	193-01	07/29/77	Tremont	1015	M	2.5	120	Snare	Good
P-4	196-01	08/02/77	US 441	1243	M	2.5	115	Snare	Gunshot
P-5	220-01	08/03/77	Chimneys	1335	F	3.5	115	Free-range	Good
E-34	198-01	08/07/77	Parsons Br.	1030	F	7.5	120	Snare	Fair
83	126-03	08/07/77	Cades Cove	2330	M	8.5	300	Free-range	Excellent
E-33	199-01	08/07/77	Bunker	1255	F	2.5	70	Snare	Poor
E-32	200-01	08/09/77	Parsons Br.	0935	F	1.5	50	Snare	Fair
E-31	201-01	08/10/77	Parsons Br.	1050	F	2.5	75	Snare	Fair
D-12	084-04	08/12/77	Elkmont	1400	M	9.5	275	Culvert	Excellent
E-35	202-01	08/13/77	Parsons Br.	1120	M	2.5	70	Snare	Fair
P-6	203-01	08/18/77	US 441	1630	F	6.5	115	Free-range	Fair
P-7	204-01	08/21/77	Collins Crk.	1600	M	2.5	165	Culvert	Good
P-8	205-01	08/23/77	US 441	1100	F	7.5	120	Free-range	Fair
P-10	207-01	08/23/77	Collins Crk.	1603	F	5.5	215	Free-range	Excellent
P-9	206-01	08/23/77	US 441	1110	M	1.5	40	Free-range	Good
110	157-02	08/27/77	Smokemont	0030	M	10.5	290	Free-range	Open wounds
C-20	190-02	08/28/77	Rabbit Crk.	0945	M	6.5	195	Snare	Good
A-40	208-01	08/31/77	Bote Mt.	1135	M	0.5	26	Snare	Excellent
A-41	063-02	08/31/77	Bote Mt.	1335	F	9.5	90	Snare	Poor
A-43	211-01	09/01/77	Bote Mt.	1730	M	1.5	23	Snare	Good

BEAR	INDEX	DATE	LOCATION	TIME	SEX	AGE	WT	CAPT TECH	CONDITION
H-45	092-02	09/04/77	Bote Mt.	1150	F	11.5	120	Snare	Good
H-2	042-03	09/05/77	Bote Mt.	1050	F	12.0	122	Snare	Good
A-46	213-01	09/05/77	Bote Mt.	1255	F	3.5	80	Snare	Fair
H-3	101-03	09/05/77	Bote Mt.	1320	F	8.5	105	Snare	Fair
A-48	071-05	09/18/77	Bote Mt.	1330	M	7.5	190	Snare	Collar wound
A-47	214-01	09/18/77	Bote Mt.	1115	M	2.5	160	Snare	Fair
A-9	136-03	09/20/77	Bote Mt.	1106	F	3.5	115	Snare	Good
A-50	215-01	09/21/77	Bote Mt.	1240	M	5.5	210	Snare	Excellent
A-49	216-01	09/21/77	Bote Mt.	1005	M	1.5	55	Snare	Excellent
A-52	217-01	09/22/77	Bote Mt.	1030	M	7.5	265	Snare	Excellent
A-54	218-01	09/24/77	Bote Mt.	1300	M	3.5	170	Snare	Good
706	275-01	05/16/78	Cosby	1600	M	NA	130	Culvert	Open wound
403	243-02	06/06/78	Parsons Br.	0900	F	3.0	95	Barrel	Fair
451	222-01	06/18/78	Cades Cove	0900	M	3.0	140	Culvert	Good
452	223-01	06/19/78	Cataloochee	2200	M	3.0	220	Culvert	Good
301	623-01	06/23/78	Tellico	1115	M	6.0	230	Snare	Excellent
307	626-01	06/25/78	Tellico	1124	F	3.0	84	Snare	Good
306	625-01	06/25/78	Tellico	0950	F	4.0	92	Snare	Fair
453	240-01	06/26/78	Smokemont	1530	F	5.0	160	Free-range	Excellent
352	225-01	06/27/78	Collins Crk.	2330	M	3.0	80	Free-range	Excellent
353	241-01	06/27/78	Chimneys	2345	M	4.0	110	Free-range	Good
459	242-01	06/28/78	Bote Mt.	1157	F	3.0	60	Snare	Fair
401	226-01	06/28/78	Parsons Br.	1330	M	3.0	100	Barrel	Fair
303	627-01	06/28/78	Tellico	1035	M	2.0	75	Snare	Fair
404	244-01	06/29/78	Parsons Br.	1804	F	3.0	105	Barrel	Poor
402	227-01	06/29/78	Parsons Br.	1430	M	4.0	200	Free-range	Good
321	201-02	06/29/78	Parsons Br.	1247	F	3.0	95	Barrel	Fair
360	260-03	06/30/78	US 441	0900	M	2.0	140	Free-range	Gunshot
462	211-01	07/01/78	Bote Mt.	1700	M	1.5	130	Snare	Fair
461	099-02	07/01/78	Bote Mt.	1430	M	9.0	200	Snare	Good
452	223-02	07/03/78	Athens, Tn.	0918	M	3.0	220	Free-range	Good
354	245-01	07/03/78	Backctry 37	1510	F.	5.0	100	Culvert	Good
464	231-01	07/09/78	Bote Mt.	1735	M	3.0	90	Snare	Fair
308	628-01	07/09/78	Tellico	1000	F	3.0	95	Snare	Fair
465	232-01	07/11/78	Bote Mt.	0948	M	3.0	145	Snare	Fair
309	629-01	07/11/78	Tellico	1041	M	2.0	80	Snare	Fair
373	233-01	07/13/78	Chimneys	1700	M	NA	128	Free-range	Good
356	248-01	07/17/78	Chimneys	2330	F	8.0	150	Free-range	Excellent
355	234-01	07/17/78	Chimneys	2345	M	4.0	137	Free-range	Fair
466	235-01	07/22/78	Tremont	1145	M	4.0	147	Snare	Good
467	249-01	07/25/78	Tremont	1140	M	3.0	105	Snare	Good
455	251-01	07/31/78	Tremont	1100	F	NA	70	Snare	Fair
304	630-01	08/03/78	Tellico	1040	F	2.0	102	Snare	Fair
454	250-01	08/05/78	Tremont	130	F	9.0	85	Snare	Fair
313	633-01	08/07/78	Tellico	1000	F	2.0	75	Snare	Good
456	253-01	08/09/78	Sugarland Mt.	0925	F	1.0	45	Snare	Good
457	097-04	08/09/78	Sugarland Mt.	1200	F	9.5	140	Snare	Good
468	236-01	08/11/78	Sugarland Mt.	1030	M	3.0	90	Snare	Good
401	226-02	08/12/78	Bunker	1015	M	3.0	120	Barrel	Fair
307	626-02	08/12/78	Tellico	1115	F	2.0	80	Snare	Fair
469	237-01	08/12/78	Sugarland Mt.	0930	M	7.0	305	Snare	Good
405	185-02	08/12/78	Bunker	1155	M	3.5	90	Barrel	Good
E-7	060-03	08/13/78	Parsons Br.	1150	F	7.0	125	Barrel	Fair

BEAR	INDEX	DATE	LOCATION	TIME	SEX	AGE	WT	CAPT TECH	CONDITION
306	625-02	08/13/78	Tellico	1035	F	4.0	80	Snare	Good
406	255-01	08/13/78	Bunker	1515	M	1.0	63	Barrel	Fair
358	256-01	08/14/78	Cosby	2200	M	NA	120	Culvert	Good
308	628-02	08/16/78	Tellico	1015	F	3.0	85	Barrel	Fair
315	618-02	08/17/78	Tellico	1030	M	10	175	Snare	Fair
407	238-01	08/17/78	Bunker	1015	M	NA	42	Barrel	Poor
408	182-02	08/17/78	Bunker	1200	F	7.0	115	Barrel	Fair
409	257-01	08/18/78	Bunker	1415	M	3.0	120	Barrel	Good
361	261-01	08/23/78	US 441	1455	M	1.0	75	Culvert	Excellent
316	631-01	08/24/78	Tellico	1045	F	2.0	105	Snare	Fair
305	624-02	08/24/78	Tellico	0950	F	6.0	105	Snare	Fair
410	262-01	08/25/78	Bunker	1015	M	1.0	58	Barrel	Excellent
411	263-01	08/25/78	Bunker	1200	M	2.0	70	Barrel	Fair
366	084-05	08/31/78	Elkmont	0900	M	10.5	500	Free-range	Excellent
317	632-01	09/01/78	Tellico	1000	M	1.0	110	Snare	Poor
413	264-01	09/01/78	Parsons Br.	1000	M	4.0	132	Barrel	Fair
472	268-01	09/04/78	Bote Mt.	0940	F	3.0	65	Snare	Fair
473	267-01	09/04/78	Bote Mt.	1120	F	3.0	80	Snare	Fair
476	266-01	09/04/78	Bote Mt.	1440	F	5.0	125	Snare	Good
414	269-01	09/05/78	Parsons Br.	1030	F	3.0	100	Barrel	Fair
479	271-01	09/06/78	Bote Mt.	1820	M	4.0	175	Snare	Good
480	039-07	09/07/78	Bote Mt.	1100	F	11.0	NA	Snare	Good
481	069-03	09/09/78	Bote Mt.	1100	F	8.0	130	Snare	Excellent
482	272-01	09/10/78	Bote Mt.	1030	F	3.0	105	Snare	Excellent
478	270-02	09/10/78	Bote Mt.	0935	M	2.0	125	Barrel	Good
367	197-02	09/12/78	Cades Cove	1215	M	9.0	250	Culvert	Open wound
458	192-02	09/12/78	Cades Cove	0300	M	10.0	250	Culvert	Excellent
470	265-01	09/13/78	Bote Mt.	1320	M	2.0	80	Free-range	Poor
603	279-02	05/17/79	Cosby	0200	M	4.0	235	Free-range	Open wound
604	206-02	05/18/79	Chimneys	1705	M	3.5	98	Free-range	Poor
605	280-01	05/20/79	Newfound Gap	1800	M	5.0	200	Free-range	Fair
606	203-04	05/28/79	US 441	1455	F	8.0	120	Free-range	Fair
607	281-01	06/01/79	Cataloochee	1000	M	3.0	170	Culvert	Fair
322	637-01	06/02/79	Tellico	1000	M	4.0	180	Snare	Good
416	282-01	06/02/79	Parsons Br.	1102	M	3.0	75	Barrel	Good
331	NA	06/03/79	Tellico	0935	M	4.0	160	Snare	Good
608	186-02	06/04/79	US 441	1025	F	4.5	120	Free-range	Fair
474	283-02	06/04/79	Bote Mt.	0900	M	2.0	115	Snare	Fair
475	284-01	06/04/79	Bote Mt.	0940	M	NA	135	Snare	Fair
609	220-03	06/04/79	US 441	1430	F	4.0	150	Free-range	Good
486	288-01	06/05/79	Bote Mt.	1125	F	3.0	75	Snare	Fair
334	NA	06/05/79	Tellico	0946	M	3.0	100	Snare	Fair
403	243-02	06/06/79	Parsons Br.	1030	F	4.0	95	Barrel	Fair
401	226-03	06/06/79	Parsons Br.	1245	M	4.0	180	Barrel	Fair
487	111-02	06/06/79	Bote Mt.	1035	F	14.0	110	Snare	Fair
326	NA	06/07/79	Tellico	0940	F	1.0	30	Snare	Fair
322	637-02	06/07/79	Tellico	1045	M	4.0	180	Snare	Good
327	NA	06/08/79	Tellico	1000	F	3.0	90	Snare	Good
610	324-01	06/11/79	Chimneys	1819	M	3.0	140	Free-range	Poor
549	290-01	06/11/79	Chimneys	2100	F	12.0	150	Free-range	Good
612	291-01	06/12/79	Chimneys	0900	M	1.0	50	Free-range	Fair
490	293-01	06/12/79	Bote Mt.	0840	M	2.0	75	Snare	Fair
550	292-01	06/12/79	Chimneys	2100	M	2.0	65	Free-range	Poor

BEAR	INDEX	DATE	LOCATION	TIME	SEX	AGE	WT	CAPT TECH	CONDITION
335	NA	06/14/79	Tellico	0950	M	4.0	155	Snare	Good
309	629-02	06/15/79	Tellico	0950	M	3.0	108	Snare	Good
336	634-01	06/15/79	Tellico	1005	F	3.0	100	Snare	Fair
306	625-02	06/15/79	Tellico	1000	F	4.0	90	Snare	Fair
337	635-01	06/15/79	Tellico	1114	M	3.0	115	Snare	Good
419	291-01	06/17/79	Parsons Br.	1130	M	1.0	50	Barrel	Fair
420	295-01	06/17/79	Bunker	1300	M	1.0	65	Barrel	Fair
321	201-04	06/22/79	Bunker	0930	F	4.0	112	Snare	Poor
405	185-03	06/22/79	Bunker	1400	M	4.5	100	Barrel	Fair
613	296-01	06/22/79	Chimneys	1830	M	3.0	140	Free-range	Fair
492	139-02	06/27/79	Bote Mt.	0930	M	4.0	125	Snare	Fair
575	240-02	06/27/79	Smokemont	2130	F	6.0	160	Free-range	Good
576	297-01	06/27/79	Smokemont	1130	F	12.0	220	Free-range	Excellent
303	627-03	06/29/79	Tellico	1100	M	3.0	90	Snare	Fair
614	205-02	06/30/79	US 441	1100	F	9.0	140	Free-range	Fair
615	296-01	06/30/79	US 441	0900	M	3.0	140	Free-range	Gunshot
616	298-01	06/30/79	US 441	1600	F	3.0	70	Free-range	Fair
337	635-02	07/04/79	Tellico	1005	M	3.0	115	Snare	Fair
307	626-04	07/07/79	Tellico	1120	F	3.0	90	Snare	Fair
493	164-03	07/11/79	Sugarland Mt.	1000	M	8.5	350	Snare	Excellent
458	276-02	07/12/79	Sugarland Mt.	1040	F	2.0	55	Snare	Poor
343	638-01	07/12/79	Tellico	1200	F	2.0	80	Snare	Good
305	624-01	07/13/79	Tellico	1004	F	7.0	110	Snare	Fair
494	299-01	07/13/79	Sugarland Mt.	1115	F	6.0	65	Snare	Poor
495	300-01	07/14/79	Sugarland Mt.	1223	M	3.0	120	Snare	Fair
422	301-01	07/15/79	Bunker	1130	M	5.0	155	Barrel	Poor
496	302-01	07/17/79	Sugarland Mt.	1050	M	4.0	120	Snare	Fair
F-21	180-02	07/18/79	Sugarland Mt.	1110	F	5.0	85	Snare	Poor
338	639-01	07/18/79	Tellico	1045	F	3.0	90	Snare	Fair
495	300-02	07/19/79	Sugarland Mt.	1050	M	3.0	120	Snare	Open wound
498	304-02	07/27/79	Bote Mt.	1200	F	2.0	75	Barrel	Poor
490	293-02	07/30/79	Bote Mt.	1155	M	2.0	85	Barrel	Fair
620	308-01	07/31/79	Smokemont	2300	F	12.0	170	Free-range	Good
609	220-04	07/31/79	US 441	1400	F	4.0	140	Free-range	Good
618	307-01	07/31/79	US 441	1400	F	0.5	16	Free-range	Deceased
617	306-01	07/31/79	US 441	1400	M	0.5	17	Free-range	Good
424	309-01	08/10/79	Parsons Br.	1000	F	7.0	95	Snare	Poor
621	084-06	08/11/79	Elkmont	0930	M	11.5	275	Free-range	Excellent
501	311-01	08/13/79	Tremont	0825	M	0.5	10	Snare	Good
426	310-01	08/13/79	Parsons Br.	0945	F	2.0	70	Snare	Fair
502	193-02	08/14/79	Bote Mt.	1035	M	4.0	150	Snare	Good
427	312-01	08/14/79	Parsons Br.	1000	F	3.0	70	Snare	Good
549	290-02	08/21/79	Chimneys	1630	F	12.0	150	Free-range	Good
471	265-02	08/23/79	Bote Mt.	1100	F	3.0	80	Snare	Poor
503	071-06	08/26/79	Bote Mt.	1050	M	9.5	170	Snare	Fair
504	313-01	08/30/79	Bote Mt.	1040	M	5.0	150	Snare	Fair
578	316-01	09/04/79	Smokemont	1000	M	1.5	33	Free-range	Skin infect.
579	317-01	09/04/79	Smokemont	0944	M	1.5	45	Free-range	Fair
577	297-02	09/04/79	Smokemont	0944	F	12.0	205	Free-range	Excellent
585	319-01	09/04/79	Smokemont	0957	M	1.5	45	Free-range	Fair
584	318-01	09/04/79	Smokemont	0951	M	0.5	16	Free-range	Fair
586	320-01	10/16/79	Cosby	2330	M	3.0	175	Culvert	Fair
588	322-01	10/22/79	Gatlinburg	1030	F	0.5	17	Free-range	Good

BEAR	INDEX	DATE	LOCATION	TIME	SEX	AGE	WT	CAPT TECH	CONDITION
589	323-01	10/22/79	Gatlinburg	1100	F	0.5	15	Free-range	Deceased
590	321-01	10/22/79	Gatlinburg	1100	F	6.0	122	Free-range	Fair
486	288-02	03/03/80	Bote Mt.	1030	F	4.0	140	Den/drug	Good
476	266-03	03/08/80	Bote Mt.	1015	F	7.0	190	Den/drug	Excellent
614	205-03	06/07/80	US 441	1520	F	10.0	90	Free-range	Gunshot
622	333-01	06/09/80	Cades Cove	1940	F	1.0	65	Free-range	Open wound
624	206-03	06/10/80	US 441	1540	M	3.0	150	Free-range	Good
419	362-02	06/15/80	Parsons Br.	0904	M	2.0	95	Snare	Fair
428	334-01	06/16/80	Bunker	1030	M	2.0	75	Snare	Good
321	201-05	06/16/80	Bunker	0840	F	5.0	100	Barrel	Fair
586	320-03	07/29/80	Cosby	2330	M	3.0	200	Free-range	Gunshot
621	084-07	08/07/80	Elkmont	2220	M	12.5	325	Free-range	Excellent
3082	329-01	08/23/80	Fight Crk.	1915	M	3.0	145	Road kill	Deceased

APPENDIX B

HEMATOLOGICAL PARAMETERS

	BEAR	INDEX	DATE	SEX	AGE	WT	WBC	RBC	HGB	PCV	MCV	MCH	MCHC
1	P-1	172-01	06/01/77	M	2.5	100	6.0	6.79	14.4	45.0	70	21.2	32.0
2	91	173-01	06/12/77	M	10.5	220	18.8	7.35	16.7	48.5	72	22.7	34.4
3	0-10	094-02	06/14/77	M	10.5	210	11.9	5.58	12.5	38.1	73	22.4	32.8
4	D-11	174-01	06/16/77	M	3.5	105	14.7	6.87	15.2	43.1	68	22.1	35.3
5	D-14	130-02	06/19/77	M	9.5	250	17.3	6.26	13.5	38.7	66	21.6	34.9
6	D-13	093-02	06/19/77	M	5.5	152	8.5	7.04	13.6	42.0	64	19.3	32.4
7	D-15	175-01	06/20/77	M	6.5	180	12.6	7.26	16.3	46.3	69	22.5	35.2
8	D-16	176-01	06/21/77	F	8.5	147	14.0	6.84	14.1	40.4	63	20.6	34.9
9	93	177-01	06/22/77	M	1.5	70	8.2	6.52	13.9	39.6	64	21.3	35.1
10	P-2	178-01	06/23/77	M	1.5	70	8.4	6.63	13.3	39.3	63	20.0	33.8
11	F-4	164-02	06/27/77	M	6.5	210	17.3	8.2	19.0	51.6	69	23.2	36.8
12	F-10	179-01	06/28/77	M	9.5	350	14.6	8.7	21.0	54.4	68	24.1	38.6
13	E-7	060-02	06/29/77	F	14.5	110	12.4	6.53	14.8	40.3	66	22.7	36.7
14	F-5	097-03	06/29/77	F	8.5	110	12.7	7.68	15.7	44.3	62	20.4	35.4
15	C-5	148-02	06/29/77	M	5.5	145	9.0	7.8	17.4	46.8	65	22.3	37.2
16	P-1	172-02	06/30/77	M	12.0	105	13.0	8.52	19.3	50.0	64	22.7	38.6
17	F-21	180-01	06/30/77	F	3.5	62	18.7	7.99	17.2	46.0	63	21.5	37.4
18	E-60	182-01	07/02/77	F	6.5	100	14.2	7.40	16.0	44.8	66	21.6	35.7
19	E-8	181-01	07/02/77	M	3.5	80	23.5	6.54	14.6	40.5	66	22.3	36.1
20	E-23	183-01	07/03/77	M	6.5	200	18.2	8.59	17.4	49.4	63	20.3	35.2
21	E-24	185-01	07/03/77	M	2.5	55	21.8	6.78	15.6	42.6	67	23.0	36.6
22	F-13	184-01	07/03/77	F	11.5	105	19.2	8.29	17.3	50.8	67	20.9	34.0
23	P-3	186-01	07/11/77	F	2.5	80	12.4	6.63	13.7	37.5	60	20.7	36.5
24	B-10	187-01	07/22/77	F	6.5	90	27.3	6.41	13.7	39.5	64	21.37	34.68
25	C-10	159-02	07/22/77	M	4.5	137	8.9	7.43	15.0	44.0	65	20.19	34.09
26	B-15	192-01	07/24/77	M	9.5	160	15.6	8.03	17.5	49.5	67	21.79	35.35
27	C-2	144-04	07/26/77	M	8.5	310	12.5	9.02	17.6	51.9	63	19.51	33.91
28	B-17	195-01	07/28/77	F	6.5	85	18.2	7.49	14.6	41.7	60	19.49	35.01
29	C-22	194-01	07/28/77	F	6.5	115	20.2	7.67	15.4	46.1	66	20.08	33.41
30	B-16	193-01	07/29/77	M	2.5	120	19.6	6.88	13.9	41.6	65	20.2	33.41
31	P-4	196-01	08/02/77	M	2.5	115	16.8	6.88	14.2	40.5	63	20.64	35.06
32	P-5	220-01	08/03/77	F	3.5	115	14.0	6.38	13.5	37.5	62	21.16	36.0
33	B-18	170-02	08/03/77	F	1.5	28	15.6	7.26	14.9	41.0	61	20.52	36.34
34	83	126-03	08/07/77	M	8.5	300	13.1	8.46	18.2	50.4	65	21.51	36.11
35	E-33	199-01	08/07/77	F	2.5	70	15.0	7.40	14.7	42.5	62	19.86	34.59
36	E-34	198-01	08/07/77	F	7.5	120	18.0	5.95	13.5	38.0	69	22.69	35.53
37	E-32	200-01	08/09/77	F	1.5	50	17.7	6.58	13.9	39.8	65	21.12	34.92
38	E-31	201-01	08/10/77	F	2.5	75	23.5	7.03	14.7	44.7	68	20.91	32.89
39	D-12	084-04	08/12/77	M	9.5	275	23.9	8.29	18.6	52.0	69	22.4	35.8
40	E-35	202-01	08/13/77	M	2.5	70	14.2	7.31	17.8	50.2	67	24.35	35.46
41	P-6	203-01	08/18/77	F	6.5	115	10.3	7.59	17.4	47.2	60	22.92	36.86
42	P-7	204-01	08/21/77	M	2.5	165	11.6	6.06	12.5	40.7	65	20.63	30.71
43	P-9	206-01	08/23/77	M	1.5	40	11.3	6.98	13.5	42.9	59	19.34	31.47
44	P-8	205-01	08/23/77	F	7.5	120	11.8	6.20	13.3	40.8	83	21.45	32.60
45	P-10	207-01	08/23/77	F	5.5	215	10.5	7.65	16.8	49.9	63	21.96	33.67
46	110	157-02	08/27/77	M	10.5	290	13.8	7.90	17.8	52.2	65	22.53	34.08
47	C-20	190-02	08/28/77	M	6.5	195	14.4	7.90	17.7	51.9	70	22.41	34.10
48	A-41	063-02	08/31/77	F	9.5	90	10.5	6.94	15.4	47.3	66	22.19	35.56
49	A-40	208-01	08/31/77	M	0.5	26	10.0	6.41	13.9	41.5	62	21.68	33.49
50	A-43	211-01	09/01/77	M	1.5	23	13.0	6.80	15.2	45.7	65	22.35	33.26

	BEAR	INDEX	DATE	SEX	AGE	WT	WBC	RBC	HGB	PCV	MCV	MCH	MCHC
51	A-45	092/02	09/04/77	F	11.5	120	16.8	6.01	13.2	41.8	67	21.96	31.58
52	A-46	213-01	09/05/77	F	3.5	80	19.5	6.76	16.1	48.7	69	23.82	33.06
53	H-2	042-03	09/05/77	F	12.0	122	9.0	6.09	13.7	41.5	66	22.5	33.01
54	H-3	101-03	09/05/77	F	8.5	105	9.4	6.30	13.6	41.5	63	21.59	32.77
55	A-47	214-01	09/18/77	M	2.5	160	19.3	7.12	14.9	46.0	63	20.93	32.39
56	A-9	136-03	09/20/77	F	3.5	115	16.0	6.60	15.5	46.9	68	23.48	33.05
57	A-49	216-01	09/21/77	M	1.5	55	19.9	7.23	16.4	47.3	63	22.68	34.67
58	A-50	215-01	09/21/77	M	5.5	210	18.3	6.61	14.1	42.5	62	21.33	33.17
59	A-52	217-01	09/22/77	M	7.5	265	20.2	7.00	15.1	45.8	63	21.57	33.0
60	A-54	218-01	09/24/77	M	3.5	170	21.4	7.84	16.6	48.2	60	21.17	34.44
61	403	243-02	06/06/78	F	3.0	95	16.8	6.89	14.6	46.2	69		
62	451	222-01	06/18/78	M	3.0	140	17.0	9.29	19.0	56.5	64		
63	452	223-01	06/19/78	M	3.0	220	7.8	8.52	17.5	53.5	66		
64	301	623-01	06/23/78	M	6.0	230	10.1	6.68	15.8	45.8	71		
65	307	626-01	06/25/78	F	3.0	84	6.9	5.64	11.7	35.4	65		
66	306	625-01	06/25/78	F	4.0	92	11.1	8.63	18.7	51.7	63		
67	453	240-01	06/26/78	F	5.0	160	9.2	7.00	14.4	42.0	60		
68	352	225-01	06/27/78	M	3.0	80	6.0	6.15	13.2	39.4	66		
69	353	241-01	06/27/78	M	4.0	110	9.6	6.04	12.6	39.0	67		
70	303	627-01	06/28/78	M	2.0	75	7.8	7.18	15.4	45.3	66		
71	401	226-01	06/28/78	M	3.0	100	11.8	6.91	15.0	44.4	67		
72	459	242-01	06/28/78	F	3.0	60	2.2	4.60	9.4	28.5	84		
73	321	210-02	06/29/78	F	3.0	95	9.6	7.72	16.8	53.4	72		
74	404	244-01	06/29/78	F	3.0	105	10.3	7.81	17.1	51.5	68		
75	360	260-03	06/30/78	M	2.0	140	6.8	6.39	15.0	42.6	68		
76	461	099-02	07/01/78	M	9.0	200	21.6	8.12	18.3	55.9	70		
77	462	211-01	07/01/78	M	1.5	130	12.6	7.08	15.8	50.0	73		
78	452	223-02	07/03/78	M	3.0	220	12.4	6.85	14.5	43.0	65		
79	354	245-01	07/03/78	F	5.0	100	5.7	5.41	12.6	37.6	71		
80	464	231-01	07/09/78	M	3.0	90	15.2	6.89	16.0	51.0	77		
81	308	628-01	07/09/78	F	3.0	95	10.0	7.70	17.7	47.8	66		
82	465	232-01	07/11/78	M	3.0	145	15.4	7.68	16.3	50.4	68		
83	373	233-01	07/13/78	M	NA	128	12.1	5.70	13.2	37.7	68		
84	355	234-01	07/17/78	M	4.0	137	17.0	7.33	16.6	48.9	69		
85	356	248-01	07/17/78	F	8.0	150	16.7	8.20	18.5	54.3	69		
86	467	249-01	07/25/78	M	3.0	105	15.0	6.76	16.2	48.4	68		
87	455	251-01	07/31/78	F	NA	70	12.5	7.35	15.3	46.0	65		
88	304	630-01	08/03/78	F	2.0	102	16.8	7.70	16.9	51.5	70		
89	454	250-01	08/05/78	F	9.0	85	11.9	6.71	14.8	45.0	70		
90	313	633-01	08/07/78	F	2.0	75	18.7	8.37	18.3	54.5	67		
91	457	097-04	08/09/78	F	9.5	140	13.7	7.36	15.4	45.5	64		
92	456	253-01	08/09/78	F	1.0	45	14.9	7.40	15.2	44.9	63		
93	468	236-01	08/11/78	M	3.0	90	16.7	8.19	18.5	49.4	64		
94	405	185-02	08/12/78	M	3.5	90	11.6	7.52	16.6	46.4	64		
95	401	226-02	08/12/78	M	3.0	120	11.9	7.53	18.3	48.7	68		
96	469	237-01	08/12/78	M	7.0	305	11.3	7.00	17.5	45.6	68		
97	E-7	060-03	08/13/78	F	7.0	125	10.4	7.64	17.6	48.1	66		
98	406	255-01	08/13/78	M	1.0	63	7.4	7.93	17.5	49.0	65		
99	358	256-01	08/14/78	M	NA	120	10.3	4.61	11.9	31.7	70		
100	407	238-01	08/17/78	M	NA	42	14.8	6.58	15.4	42.2	66		
101	408	182-02	08/17/78	F	7.0	115	6.9	7.02	15.3	43.3	65		
102	409	257-01	08/18/78	M	3.0	120	8.8	7.33	15.4	46.4	66		
103	361	261-01	08/23/78	M	1.0	75	9.6	8.29	19.6	51.3	66		

	BEAR	INDEX	DATE	SEX	AGE	WT	WBC	RBC	HGB	PCV	MCV	MCH	MCHC
104	316	631-01	08/24/78	F	2.0	105	11.9	8.08	18.3	55.2	71		
105	305	624-02	08/24/78	F	6.0	105	9.1	7.26	16.1	45.6	66		
106	410	262-01	08/25/78	M	1.0	58	11.9	7.63	16.6	48.0	66		
107	411	263-01	08/25/78	M	2.0	70	5.2	8.13	17.4	52.8	68		
108	365	084-05	08/31/78	M	10.5	500	10.3	7.18	16.5	48.2	69		
109	317	632-01	09/01/78	M	1.0	110	15.1	7.99	18.3	52.4	68		
110	413	264-01	09/01/78	M	4.0	132	6.1	7.93	16.1	48.3	64		
111	470	265-01	09/03/78	F	2.0	50	15.3	8.65	18.0	53.3	65		
112	472	268-01	09/04/78	F	3.0	65	14.2	7.73	17.1	51.8	70		
113	473	267-01	09/04/78	F	3.0	80	16.1	7.75	16.9	51.3	69		
114	414	269-01	09/05/78	F	3.0	100	10.3	8.03	17.2	48.2	63		
115	479	271-01	09/05/78	M	4.0	175	17.6	6.23	13.8	39.1	64		
116	480	039-07	09/07/78	F	11.0	NA	11.8	7.48	17.0	48.6	68		
117	481	069-03	09/09/78	F	8.0	130	10.8	8.37	18.0	53.0	67		
118	478	270-02	09/10/78	M	2.0	125	16.3	6.36	13.9	40.6	66		
119	482	272-01	09/10/78	F	3.0	105	13.7	6.61	16.0	44.4	70		
120	458	192-02	09/12/78	M	10	250	14.0	7.85	17.0	46.5	63		
121	367	192-02	09/12/78	M	9.0	250	9.2	6.33	13.9	39.5	65		
122	601	277-01	04/29/79	M	2.0	80	10.9	8.86	18.9	57.0			
123	603	279-02	05/18/79	M	3.5	98	9.1	7.92	17.0	52.0			
125	605	280-01	05/20/79	M	5.0	200	7.3	6.83	14.7	44.0			
126	606	203-04	05/28/79	F	8.0	120	6.9	7.88	17.0	51.0			
127	607	281-01	05/01/79	M	3.0	170	9.5	8.59	18.4	53.0			
128	322	637-01	06/02/79	M	4.0	180	12.9	7.42	16.5	54.0			
129	475	284-01	06/04/79	M	NA	135	10.9	6.72	13.7	43.0			
130	474	283-02	06/04/79	M	2.0	115	8.7	6.74	13.3	38.5			
131	609	220-03	06/04/79	F	4.0	150	6.1	6.91	14.4	43.0			
132	608	186-02	06/04/79	F	4.5	120	9.9	8.85	18.0	52.0			
133	486	288-01	06/05/79	F	3.0	75	16.4	6.85	13.7	42.0			
134	334	NA	06/05/79	M	3.0	100	8.7	7.83	17.3	52.0			
135	487	111-02	06/06/79	F	14.0	110	14.6	8.45	17.4	50.0			
136	401	226-03	06/06/79	M	4.0	180	8.2	7.46	17.1	51.0			
137	403	243-02	06/06/79	F	4.0	95	9.2	6.92	14.2	49.0			
138	322	637-02	06/07/79	M	4.0	180	16.8	7.81	17.2	53.0			
139	326	NA	06/07/79	F	1.0	30	15.1	6.25	12.2	41.0			
140	322	637-02	06/07/79	M	4.0	180	17.5	8.17	18.4	56.0			
141	327	NA	06/08/79	F	3.0	90	10.9	6.89	15.4	46.0			
142	549	290-01	06/11/79	F	12.0	150	7.5	4.48	9.7	30.0			
143	610	324-01	06/11/79	M	3.0	140	38.2	6.92	15.4	28.0			
144	490	293-01	06/12/79	M	2.0	75	10.9	6.65	14.4	44.0			
145	612	291-01	06/12/79	M	1.0	50	48.9	5.59	14.1	22.0			
146	550	292-01	06/12/79	M	2.0	65	12.6	5.20	10.9	35.0			
147	335	NA	06/14/79	M	4.0	155	12.5	8.30	18.3	53.0			
148	309	629-02	06/15/79	M	3.0	108	7.0	8.10	18.2	50.0			
149	336	634-01	06/15/79	F	3.0	100	14.3	7.20	15.4	45.0			
150	306	625-02	06/15/79	F	4.0	90	13.3	7.40	15.6	48.0			
151	337	635-01	06/15/79	M	3.0	115	13.4	7.23	16.3	49.0			
152	419	291-01	06/17/79	M	1.0	50	7.8	6.18	12.8	39.0			
153	420	295-01	06/17/79	M	1.0	65	6.0	6.41	14.5	43.0			
154	613	296-01	06/22/79	M	3.0	140	8.5	8.92	18.5	57.0			
155	405	185-03	06/22/79	M	4.5	100	6.5	6.36	14.5	45.0			
156	492	139-02	06/27/79	M	4.0	125	9.5	5.97	14.3	45.0			
157	576	297-01	06/27/79	F	12.0	220	9.0	6.44	14.1	42.0			

	BEAR	INDEX	DATE	SEX	AGE	WT	WBC	RBC	HGB	PCV	MCV	MCH	MCHC
158	575	240-02	06/27/79	F	6.0	160	9.5	7.12	14.6	42.0			
159	615	296-01	06/30/79	M	3.0	140	12.8	5.56	13.4	36.0			
160	616	296-01	06/30/79	F	3.0	70	11.5	5.36	13.0	35.0			
161	614	205-02	06/30/79	F	9.0	140	8.6	6.60	15.3	41.0			
162	337	635-02	07/04/79	M	3.0	115	14.4	7.36	16.3	53.0			
163	307	626-04	07/07/79	F	3.0	90	9.0	7.60	16.8	52.0			
164	493	164-03	07/11/79	M	8.5	350	16.7	8.15	18.8	58.0			
165	458	276-02	07/12/79	F	2.0	55	11.9	8.00	17.6	52.0			
166	494	299-01	07/13/79	F	6.0	65	20.7	4.44	8.9	31.0			
167	305	624-01	07/13/79	F	7.0	110	12.1	7.03	15.5	45.0			
168	495	300-01	07/14/79	M	3.0	120	15.4	6.89	16.8	48.0			
169	422	301-01	07/15/79	M	5.0	155	5.6	8.24	17.8	55.0			
170	338	639-01	07/18/79	F	3.0	90	14.1	6.54	14.0	45.0			
171	F-21	180-02	07/18/79	F	5.0	85	20.9	8.08	18.0	57.0			
172	495	300-02	07/19/79	M	3.0	120	19.4	7.05	15.1	49.0			
173	496	302-01	07/19/79	M	4.0	120	24.6	6.88	16.3	47.0			
174	498	304-02	07/27/79	F	2.0	75	8.9	6.64	15.6	48.0			
175	490	293-02	07/30/79	M	2.0	85	11.1	6.59	14.7	44.0			
176	617	306-01	07/31/79	M	0.5	17	14.8	6.99	14.7	41.0			
177	620	308-01	07/31/79	F	12.0	170	14.8	6.69	14.5	42.0			
178	618	307-01	07/31/79	F	0.5	16	8.6	5.53	13.2	41.0			
179	609	220-04	07/31/79	F	4.0	140	10.5	6.84	16.2	41.0			
180	424	309-01	08/10/79	F	7.0	95	25.3	6.20	14.1	43.0			
181	621	094-06	08/11/79	M	11.5	275	15.1	7.68	16.2	48.0			
182	501	311-01	08/13/79	M	0.5	10	11.1	6.21	12.2	42.0			
183	426	310-01	08/13/79	F	2.0	70	10.6	7.80	17.4	50.0			
184	502	193-02	08/14/79	M	4.0	150	16.3	7.71	16.8	47.0			
185	427	312-01	08/14/79	F	3.0	70	18.8	7.52	16.8	48.0			
186	549	290-02	08/21/79	F	12.0	150	11.7	6.02	12.1	35.0			
187	503	071-06	08/25/79	M	9.5	170	11.8	5.08	11.1	42.0			
188	504	313-01	08/30/79	M	5.0	150	17.0	6.00	13.3	42.0			
189	579	317-01	09/04/79	M	1.5	45	10.6	7.49	14.4	41.0			
190	577	297-02	09/04/79	F	12.0	205	18.5	6.20	12.5	36.0			
191	585	319-01	09/04/79	M	1.5	45	6.6	7.08	14.3	41.0			
192	584	318-01	09/04/79	M	0.5	16	12.4	6.79	13.1	37.0			
193	578	316-01	09/04/79	M	1.5	33	8.7	6.74	13.3	38.5			
194	586	320-01	10/16/79	M	3.0	175	9.4	7.92	15.7	46.0			
195	589	323-01	10/22/79	F	0.5	15	6.4	6.63	11.3	34.0			
196	588	322-01	10/22/79	F	0.5	17	5.8	6.73	12.2	36.0			
197	590	321-01	10/22/79	F	6.0	122	16.3	9.12	18.0	51.0			
198	614	205-03	06/07/80	F	10.0	90	9.1	4.97	11.0	33.0			
199	622	333-01	06/09/80	F	1.0	65	10.7	7.59	15.8	46.0			
200	419	362-02	05/15/80	M	2.0	95	12.8	8.00	21.4	48.5			
201	321	201-05	06/16/80	F	5.0	100	8.9	7.33	16.8	49.0			
202	428	334-01	06/16/80	M	2.0	75	13.6	8.46	17.5	49.0			
203	586	320-03	07/29/80	M	3.0	200	10.3	7.07	14.7	43.0			
204	621	084-07	08/07/80	M	12.5	325	10.7	7.22	16.0	46.0			
205	3082	329-01	08/23/80	M	3.0	145	12.3	4.55	11.1	31.0			

APPENDIX C

MICROSCOPIC OBSERVATIONS

	DATE	SEG	STAB	LYMPH	MONO	EOS	BASO	RETIC	PLT	ESR	COMMENTS	1977-1980 D. URSI
1	06/01/77	62	6	20	8	4			596			+
2	06/12/77	96		2	2				372			
3	06/14/77	93		7					432		4 NRBC	
4	06/16/77	85	5	9	1				164			+
5	06/19/77	81	5	12	1	1			180			+
6	06/19/77	84	2	7	7							+
7	06/20/77	94		5		1			422			+
8	06/21/77	84	7	5	1	3			376			+
9	06/22/77	55	2	26	4	13			578			+
10	06/23/77	74	3	21	2				202			+
11	06/27/77	89	2	6	2	1						+
12	06/28/77	93	2	4		1			376			+
13	06/29/77	94		5		1			412		H-J BODY	+
14	06/29/77											+
15	06/29/77	81	3	11	2	3			336		H-J BODY	+
16	06/30/77	87	1	9	2	1			624			
17	06/30/77	96		4								+
18	07/02/77	74	5	21								+
19	07/02/77	93	3	3	1							+
20	07/03/77	84	3	11	1	1						+
21	07/03/77	88	4	7	1							+
22	07/03/77	80	7	12	1							+
23	07/11/77	85	2	8	3	2			556			+
24	07/22/77	84	14	1	1							+
25	07/22/77	94	1	3								+
26	07/24/77	85	4	8		1	2					
27	07/26/77	78	2	10	6	4						+
28	07/28/77	85	3	8	4							+
29	07/28/77	98		1		1						
30	07/29/77	90	2	6		2						
31	08/02/77	74		22		4			288			+
32	08/03/77	96		2	2							+
33	08/03/77	79		14	3	4			384			+
34	08/07/77	93	1	6					556			+
35	08/07/77	90		8	1	1			196			+
36	08/07/77	87	4	7	1	1						+
37	08/09/77	78	3	15	3		1		416			+
38	08/10/77	99		1					398			+
39	08/12/77	86	3	11								
40	08/13/77	88		11	1							+
41	08/18/77	83		16	1							+
42	08/21/77	76		20	2	2						+
43	08/23/77	87		10	2	1						
44	08/23/77	78		18	3	1			286			+
45	08/23/77	87		5	6	2			444			+
46	08/27/77	72	4	19	3	2						+
47	08/28/77	86	5	8	1							+
48	08/31/77	68	2	23	7							+
49	08/31/77	74		22	3	1						+
50	09/01/77	82	10	6	2							

	DATE	SEG	STAB	LYMPH	MONO	EOS	BASO	RETIC	PLT	ESR	COMMENTS	1977-1980 D. URSI
51	09/04/77	79	4	14	1	2			322			+
52	09/05/77	90	1	8	1				184			+
53	09/05/77	85	9	5	1				258			+
54	09/05/77	85	1	10	4				254			+
55	09/18/77	88		8	4				376			
56	09/20/77	82	16	2					398		H-J BODY	+
57	09/21/77	82	1	12	1	4			420		H-J BODY	+
58	09/21/77	90	5	4	1				436			+
59	09/22/77	86	7	3	1	3			296		H-J BODY	+
60	09/24/77	75	10	12	2	1						
61	06/06/78	94	1	5				0.2		1.0		+
62	06/18/78	92		5	2	1		0.1		2.0		+
63	06/23/78	95		5				0.1		1.0		+
64	06/25/78	90	1	7	1	1		0.0		1.0	4 NRBC	+
65	06/25/78	96		4				0.2		1.0		+
66	06/26/78	61	2	33	1	3		0.3		2.0		+
67	06/27/78	81	1	16	2			0.3		1.0		+
68	06/27/78	84		14		2		0.4		1.0	2 NRBC HJB	+
69	06/28/78	91		6	3			0.0		1.0	1 NRBC	+
70	06/28/78	86		10	2	2		0.0		2.0		+
71	06/28/78	82		8	2	8		0.08		2.0		+
72	06/29/78	75		23		2		0.2		1.0		+
73	06/29/78	53	1	33	1	12		0.4		1.0		+
74	06/30/78	81	2	14	2	1						
75	07/01/78	86	1	12	1			0.1		2.0		+
76	07/01/78	93	1	5		1		0.1		1.0		+
77	07/03/78	95		5				0.1		2.0		+
78	07/03/78	81	3	12	1	3		0.2		1.0	6 NRBC	+
79	07/09/78	89	1	8	1	1		0.2		1.0		+
80	07/09/78	92	1	7				0.4				+
81	07/11/78	77		21	1	1		0.2				+
82	07/13/78	80		16	2	2		0.0		1.0		+
83	07/17/78	52	1	16		29		0.5				+
84	07/17/78	86	1	12	1			0.2				+
85	07/25/78	93	2	4	1			0.5				+
86	07/31/78	78		22				0.2				+
87	08/03/78	63	3	33	1							+
88	08/05/78	93		7				0.1				+
89	08/07/78	90		9		1						+
90	08/09/78	86	2	12								+
91	08/09/78	85	1	11	3							+
92	08/11/78	91	1	7		1						+
93	08/12/78	93		7								+
94	08/12/78	78	1	15	2	4						+
95	08/12/78	69	1	24		5	1					+
96	08/13/78	82	5	12		1						+
97	08/13/78	62	5	33								+
98	08/14/78	87		12	1							
99	08/17/78	79	1	17	3							+
100	08/17/78	89	1	10								+

	DATE	SEG	STAB	LYMPH	MONO	EOS	BASO	RETIC	PLT	ESR	COMMENTS	1977-1980 D. URSI
101	08/18/78	93		7								+
102	08/23/78	79	3	14	2	2						
103	08/24/78	84		13	3							+
104	08/24/78	91	1	6	1	1						+
105	08/25/78	81		16	1	2						+
106	08/25/78	74		23		3						+
107	08/31/78	89		9	2							+
108	09/01/78	85	1	13		1						+
109	09/01/78	79	2	17	2							+
110	09/04/78	76		23		1						+
111	09/04/78	93	1	3	3							+
112	09/05/78	87	1	11	1							+
113	09/06/78	90	1	7	2							+
114	09/07/78	95		5								+
115	09/09/78	84	2	13	1							+
116	09/10/78	93		7								+
117	09/10/78	95		5								+
118	09/12/78	98	1	1							HYPERLOBED	+
119	09/12/78	93	1	6								+
120	09/13/78	90		10								+
121	04/29/79											+
122	05/17/79	66	4	13	3	14						+
123	05/18/79	57		23	3	17						+
124	05/20/79	72	1	20		7						+
125	05/28/79	70	5	21	3	1						+
126	06/01/79	87	2	8	1	2						+
127	06/02/79											
128	06/04/79	64		17	5	14						+
129	06/04/79	51	7	33	2	7					1 NRBC	
130	06/04/79	80	4	9	3	4						+
131	06/04/79	74	17	1		2						+
132	06/05/79	70	2	23		5						+
133	06/05/79	86	5	7	1	1						+
134	06/06/79	91	2	7								+
135	06/06/79	75	1	22		2						+
136	06/06/79	60	4	21	6	9						+
137	06/07/79	91	3	5	1							
138	06/07/79	93	5	1	1							
139	06/07/79	92	2	2	3	1						+
140	06/08/79	88	3	4	5							+
141	06/11/79	68	4	16	12							+
142	06/11/79	65	2	15	4	14						+
143	06/12/79	86	4	7		3						+
144	06/12/79	83	3	10	2	2						+
145	06/12/79	73	5	12		10						+
146	06/14/79											
147	06/14/79	85	2	5	5	3						
148	06/15/79											+
149	06/15/79	82	5	7	3	3						+
150	06/15/79	83	1	11	4	1						+

	DATE	SEG	STAB	LYMPH	MONO	EOS	BASO	RETIC	PLT	ESR	COMMENTS	1977-1980 D. URSI
151	06/15/79	79	3	13	3	2						+
152	06/17/79	68	4	18	5	5						+
153	06/17/79	73		18	6	3						+
154	06/22/79	50	6	29	2	13						+
155	06/22/79	50		28		22						+
156	06/27/79											+
157	06/27/79	63	2	18	2	16						+
158	06/27/79	71	6	13	4	6					2 NRBC	
159	06/30/79	72	2	13	2	11						+
160	06/30/79	71	2	11	2	14						+
161	06/30/79	65	6	18	3	8						+
162	07/04/79											
163	07/07/79											
164	07/11/79											+
165	07/12/79	88	1	5	4	2						+
166	07/13/79											+
167	07/13/79	88	8	3		1						+
168	07/14/79	86	4	6	2	2						
169	07/15/79											+
170	07/18/79	54	18	16	7							+
171	07/18/79											
172	07/19/79	86	5	6	3							
173	07/25/79	71	18	7	2							+
174	07/27/79	83		14	1	2						+
175	07/30/79	87	1	8	4							+
176	07/31/79	80	3	12	3	2						
177	07/31/79	68	6	13	4	9						+
178	07/31/79											+
179	07/31/79	82	2	15	1						1 NRBC	
180	08/10/79											
181	08/11/79	80	7	8	3	2						+
182	08/13/79											
183	08/13/79											
184	08/14/79											
185	08/14/79											
186	08/21/79	70	3	18	1	8						+
187	08/26/79											+
188	08/30/79											+
189	09/04/79	46	1	35	2	16					2 NRBC	+
190	09/04/79	86	3	4	2	5						+
191	09/04/79	57		29	4	10						+
192	09/04/79	63		23	8	6						+
193	09/04/79	83		12	3	2						+
194	10/16/79	67		22	2	9						
195	10/22/79	65	1	31	3						1 NRBC	
196	10/22/79	89	2	4	1	4						+
197	10/22/79	73		23	1	3					2 NRBC	
198	06/07/80	64		31	5							
199	06/09/80	63		18	1	18						
200	06/15/80											+
201	06/16/80											+
202	06/16/80											
203	07/29/80	64	1	23	1	9	2					+
204	08/07/80	78		11	3	8						+
205	08/23/80											+

APPENDIX D

SERUM BIOCHEMICAL PARAMETERS

BEAR	GLUCOSE	BUN	CREAT	NA	K	CL	CO_2	URIC ACID	CA	P	BUN/CREAT	NA-(CL+CO_2)
420	5	15	1.1	134	6.0	98	19	2.0	8.4	7.1	13.6	17.0
608	119	20	1.3	140	6.2	90	25	1.7	6.9	7.2	15.4	25
496	115	17	1.5	144	5.6	98	21	2.8	7.8	7.2	11.3	25
576	124	6	1.9	142	6.4	93	28	2.1	6.8	5.0	3.2	21
306	72	13	1.4	139	5.4	99	19	2.1	7.2	5.3	9.3	21
602	82	19	1.6	144	5.4	100	23	1.4	7.2	5.6	11.9	21
402	78	12	1.8	139	6.2	100	16	2.0	7.4	5.3	6.7	23
474	115	13	1.0	147	5.1	99	22	2.2	6.7	7.8	13	26
604	56	15	0.9	138	6.7	93	23	1.9	8.3	7.3	16.7	22
575	87	9	1.4	134	5.9	100	21	1.3	7.4	3.2	6.4	13
487	80	19	1.9	151	5.0	104	22	1.9	10	3.4	10	25
309	195	10	1.4	137	6.0	97	21	2.1	6.4	4.7	7.1	19
550	89	11	1.0	143	7.8	103	23	1.5	8.3	7.2	11	17
419	112	14	1.2	139	5.6	102	19	1.7	7.3	6.6	11.7	18
616	113	9	1.0	144	4.5	102	27	0.8	8.0	6.6	9.0	15
486	93	13	1.1	154	5.0	111	23	1.8	6.6	7.3	11.8	20
615	166	8	1.2	142	5.8	103	26	0.9	7.7	5.2	6.7	13
614	155	11	1.7	137	5.6	97	28	0.9	73	4.1	6.5	12
549	107	8	1.5	141	6.1	101	26	1.0	7.1	4.2	5.3	14
612	134	10	1.0	142	8.7	98	25	2.3	7	5.5	10	19
607	11	19	1.7	148	4.6	97	26	1.8	8.8	3.9	11.2	25
605	123	38	1.6	135	5.6	92	22	1.6	8.8	4.5	23.8	21
601	106	26	1.1	144	6.6	83	32	2.0	7.7	6.4	23.6	29
603	139	17	1.2	137	5.6	97	24	0.8	7.6	5.2	14.2	16
606	100	15	1.5	137	6.6	90	24	1.9	7.6	4.8	10	23
480	164	9	1.3	140	4.1	98	25	1.4	8.1	6.4	6.9	17
467	148	6	1.0	138	3.0	93	24	1.7	7.5	6.6	6	21
414	46	18	1.4	139	6.6	100	16	2.2	7.4	8.5	12.9	23
466	6	12	2.2	149	5.6	104	18	4.1	9.0	6.2	5.5	27
444	50	0	1.1	146	4.7	105	25	0.9	5.8	4.8	0	16
H2	56	1	1.6	137	6.7	95	23	1.9	7.3	5.2	0.6	19
456	61	6	1.4	146	5.9	104	18	2.3	7.4	9.8	4.3	24
366	147	26	1.3	140	5.1	102	17	1.4	8.1	5.6	20	21
A-9	64	0	1.1	142	5.9	105	21	2.2	7.9	5.3	0	16
453	70	13	1.5	136	6.0	100	22	0.9	8.1	6.3	8.7	14
307	205	45	1.8	149	5.7	112	13	2.2	7.0		25	24
361	55	24	1.2	151	6.9	110	15	2.5	7.4	9.7	20	26
E-7	36	3	1.3	140	6.6	96	13	2.7	8.2	8	2.3	31
406	29	6	1.3	137	6.9	97	15	2.3	9.5		4.6	25
445	27	0	1.2	143	5.7	109	18	2.3	7.7	2.5	0	16
H-1	21	9	1.9	148	5.6	108	22	1.9	7.6	6.3	4.7	18
358	76	4	1	142	4.2	102	28	0.8	8.1	6	4	12
358	72	3	0.9	138	4.1	98	26	2.2	7.8	5.7	3.3	14
472	118	3	1.3	137	5.2	99	19	2.4	9	6.9	2.3	19
413	74	9	1.5	145	6.2	108	19	1.6	8.2	7.4	6	18
356	13	4	1.3	142	8.3	99	16	3.4	7.9	6.8	3.1	27
354	103	10	1.4	142	4.8	106	24	0.8	8.8	5	7.1	12
313	24	11	1.2	150	6	106	17	3.2	9.1	9.4	9.2	27
455	124	11	1.6	146	4.0	107	18	2.3	8.4	7.2	6.9	21

BEAR	GLUCOSE	BUN	CREAT	NA	K	CL	CO_2	URIC ACID	CA	P	BUN/CREAT	NA-(CL+CO_2)
479	191	5	1.4	144	5	101	22	2.5	8	6.2	3.6	21
459	47	13	1.2	142	5	109	20	1.1	8	4	10.8	13
452	83	0	1.1	145	4.3	105	22	1.4	8.5	4.6	0	18
353	44	16	1.1	146	4.3	104	25	1.1	8.3	5.4	14.5	17
355	53	8	1.5	138	6.6	97	18	2.1	7.6	5.7	5.3	23
360	77	1	1	138	6.4	99	18	2.1	7.9	7.9	1	21
478	123	5	1.6	142	5.3	104	20	2.2	7.2	4.5	3.1	18
E-45	72	6	1.6	134	6.4	95	15	2.1	8.2	7.6	3.8	24
405	64	0	1.2	134	6.8	98	16	2.7	7.2	8.3	0	20
453	71	14	0.9	136	6.1	100	22	1.1	8.2	6.3	15.6	14
A-42	0	3	1.2	148	9.7	108	16	3.9	8.4	0	2.5	24
D-15	129	11	2		7.5	115	26	3	10	5.9	5.5	30
373	90	10	1.1	142	5.7	99	27	1.9	8.9	9	9.1	16
469	75	12	2.3	144	5.3	98	16	2.2	8.9	7.9	5.2	30
414	48	18	1.3	139	6.4	101	16	2.3	7.5	8.5	13.8	22
303	51	8	1.4	143	5.2	107	16	2.5	7.4	6.5	5.7	20
479	185	5	1.3	143	4.7	101	21	2.4	7.9	6	3.8	21
359	63	21	1.5	152	4.2	115	23	0.9	7.9	4.8	14	14
457	136	2	1.3	143	3.7	109	19	1.5	7.9	5.7	1.5	15
354	102	10	1.4	142	4.5	105	24	1.1	8.7	4.9	7.1	13
452		3	1.8	140	5.5	98	16	1.7	6.6	6.6	1.7	26
A-53	0	3	1.2	145	5.9	103	16	2.5	6.9	5.9	2.5	26
A-47	29	1	1.3	148	5.7	111	17	2.1	8.3	5.5	0.8	20
470	5	11	1.5	143	5.7	96	21	5.3	8.4	7.8	6.9	26
410	13	7	1.3	139	7.0	98	10	2.2	8.9		5.4	31
409	65	6	1.4	136	7.4	99	17	1.9	8.3	8.4	4.3	20
454	9	20	2.4	150	5.7	101	25	5.4	8.9	7.5	8.3	24
401	30	9	1.1	144	5.2	107	21	1.4	8.3	8.1	8.2	16
407	34	7	1.4	137	8	89	17	3.4	9.3		5	31
B-16	170	1	1.4		7.4	114	25	4	11	6.4	0.7	30
352	103	6	1.1	143	4.3	109	22	1.2	7	4.7	5.5	12
91	36	10	2.1	155	6.9	102	24	1.3	8.8	4.2	4.8	29
408	111	2	1.6	139	6.8	101	16	2.7	8	5.8	1.3	22
A-48	22	1	1.3	138	6.8	100	18	2.5	7.8	5.8	0.8	20
453	70	15	1.5	134	5.9	102	21	1.1	8.2	6.2	10	11
A-26	61	21	1.5	147	4.4	112	23	1.3	7.5	4.8	14	12
0-13	128	8	1.9	152	6.1	105	27	1.7	8.2	5.3	4.2	20
A-50	46	3	1.2	143	5.6	104	18	1.5	6.2	4.7	2.5	21
0-22	42	3	1.7		6.4	129	23	2.3	9.6	4	1.8	28
A-9	65	1	1.1	140	5.7	104	21	2.3	7.9	5.2	0.9	15
93	110	10	1.1	149	6.5	106	26	1.8	8.7	9.3	9.1	17
452	90	4	1.1	143	4.5	105	23	1.1	8.4	4.6	3.6	15
E23	6	18	2.3		5.8		22	2.1	9	3.1	7.8	26
A-49	34	3	1.1	133	7.3	88	20	3.5	7.5	8.2	2.7	25
A-53	2	3	1.1	144	5.5	102	18	2.7	7.1	5.5	2.7	24
481	30	10	1.3	145	5.8	86	23	3.1	7.3		7.7	36
D-10	198	17	1.4	138	6.4	94	24	2.1	7.3	6.4	12.1	20
D-16	81	19	1.7	140	5.2	99	22	2.3	6.9	6.2	11.2	19
E-60	89	10	2		6.3	121	21	1.7	8.4	5.6	5.0	25
462	13	12	1.8	143	5.4	97	18	2.8	8.5		6.7	28
0-12	53	14	1.5	147	5.2	101	22	2.1	9.3	6.9	9.3	24
P-10	39	7	1.2	138	5.3	99	19	1.6	7.4	6.4	5.8	20

BEAR	GLUCOSE	BUN	CREAT	NA	K	CL	CO_2	URIC ACID	CA	P	BUN/CREAT	NA-(CL+CO_2)
A-43	22	20	0.8		5.7	119	18	2.2	8.8	10	2.5	25
A-48	23	1	1.3	139	6.7	101	17	2.7	8.2	6	0.8	21
A-45	24	2	1.3	143	5.7	111	19	2.4	7.6	2.4	1.5	13
B-17	211	14	1.7	158	5.7	115	21	3.4	8.8	4.7	8.2	22
A-41	134	1	1.7	157	5.6	115	15	3.3	7.6	8.8	0.6	27
P-9	73	6	0.7	132	5.1	93	25	1.7	8.4	7	8.6	14
C-20	11	1	1.5	145	5.4	103	16	2.3	6.1	6.1	0.7	26
H-3	82	4	1.5	138	5.8	96	22	2.3	6.6	4.3	2.7	20
A-54	14	3	1.6	137	6.4	94	18	3	7.5	4.5	1.9	25
H-2	42	2	1	100	4.5	70	10	1.3	5.3	3.5	2	20
A-47	30	2	1.2	147	5.4	111	18	2.4	8.2	5.7	1.7	18
E-24	57	8	1.6		6.4	128	26	2.6	7.6	5	5	25
C-2	77		1.9	144	4.2	96	18	3.2	7.3	7.6		30
A-50	50		1.2	145	5.2	103	19	2.7	6.3	4.6		23
D-11	77		1.3	104	3.6	78	8	2	7.2	4.9		18
A-46	53		1.1	139	4.7	94	22	2.4	7.3	6.1		23
E-31	18	0	1.3	151	4.8	106	22	3.5	8	6.9		23
P-10	41		1.2	139	5.1	99	18	1.9	7.5	6.4		22
A-54	26		1.5	136	6.1	96	20	3.3	7.2	4.5		20
A-43	37		0.8		5	120	19	2.5	7	9.6		22
P-1	71		0.9	140	4.5	105	19	1.7	8.4	6.8		16
D-14	143		1.7	138	5.4	98	23	2.3	8	6.4		17
142	3		1.2	146	9.2	105	17	4.3	8.1	10		24
A-54	19	3	1.6	134	6.4	94	18	3.3	7.4	4.5	1.9	22
A-41	125	1	1.8	158	5.5	114	14	3.6	7.5	8.6	0.6	30
83	56	2	1.1	146	4.5	105	24	1.9	6	4.7	1.8	17
A-46	53	3	1	140	5.1	93	22	2.4	7.3	6.1	3	25
M-83	44	23	1.8	142	5.4	101	16	3.2	7.5	6.5	12.8	25

BIOCHEMICAL PARAMETERS

8EAR	PROTEIN	AL8UMIN	FE	CHOL	TRIGLY	BILI	ALK PHOS	LDH	SGOT	CPK	GLO8	A/G
420	6.8	3.8	70	348	378	0.1	45	579	59	118	3	1.3
608	8.1	5	390	297	212	0.2	65			186	3.1	1.6
496	7.4	4	144	264	317	0.1	38				3.4	1.2
576	6.9	3.7	212	355	147	0.1	27		86	205	3.2	1.2
306	6.9	3.9	96	268	306	0.1	36		94		3.0	1.3
602	7.5	4.2	126	397	499	0.1	56		60	223	3.3	1.3
402	7.8	4.1	145	356	334	0.1	25		321		3.7	1.1
474	7.2	3.9	113	362	272	0.2	35		315		3.3	1.2
604	6.6	3.9	332	242	247	0.1	61		92	78	2.7	1.4
575	6.6	3.6	295	289	144	0.1	21	438	48	99	3	1.2
487	7.6	4.4	78	442		0.1	33				3.2	1.4
309	7.1	3.9	275	287	262	0	51		197	808	3.2	1.2
550	6.2	4	74	209	298	0.1	35		109	215	2.2	1.8
419	6	3.5	62	418		0	36		109		2.5	1.4
616	5.7	3.3	144	195	341	0.1	54			269	2.4	1.4
486	6.4	3.7	80	276	292	0.1	48				2.7	1.4
615	5.6	3.2	150	215	281	0.1	25	498	84	417	2.4	1.3
614	5.7	3.3	150	201	149	0.1	19	486	75	139	2.4	1.4
549	6.5	3.9	107	251	462	0.1	10		240	402	2.6	1.5
612	7.4	4.4	138	229	199	0.2	35			225	3.0	1.5
607	7.2	4	110	316	399	0.1	25		224	866	3.2	1.3
605	7.5	4	205	317	377	0	55	565	70	147	3.5	1.1
601	7.8	5	192	251	238	0.1	60		120	208	2.8	1.8
603	6.1	3	128	276	291	0	19	251	50	79	3.1	1
606	6.5	3.6	140	262	194	0.1	21	404	46	81	2.9	1.2
480	6.8	3.2	155	235	214	0.2	33		75	218	3.6	0.9
467	6.7	3.2	151	258	210	0.1	43		355		3.5	0.9
414	6.8	3.5	421	255	170	0.2	38		109	72	3.3	1.1
466	8.2	4.2	157	243	242	0.2	50	190		4	1.1	
444	5.4	2.9	168	175	90	0.1	17		167	77	2.5	1.2
H-2	6.9	3.5	202	215	147	0.1	24		83	113	3.4	1
456	6.6	3.5	108	229	245	0.3	82		306		3.1	1.1
366	7.9	4.4	162	389	256	0.1	31		52	46	3.5	1.3
A-9	6.7	3.2	354	204	145	0.1	77		71	425	3.5	0.9
453	7.0	3.7	163	267	289	0.2	23		50	12	3.3	1.1
307	5.4	3.2	99	186	190	0.1	38				2.2	1.5
361	8.3	5.0	437	445	261	0.4	43			178	3.3	1.5
E-7	7.3	3.8	279	253	250	0.2	20		116	395	3.5	1.1
406	7.1	3.7	171	317	294	0.1	55		70	179	3.4	1.1
445	6.1	3.3	329	164	160	0.2	38	499	115	520	2.8	1.2
H-1	6.8	3.1	141	218	244	0.1	31		193	527	3.7	0.8
358	6.4	3.2	262	297	237	0.1	25		49	42	3.2	1
358	6.2	3.1	250	285	230	0.2	27		53	58	3.1	1.0
472	6.5	3.2	199	245	230	0.1	81		100	340	3.3	1
413	6.9	3.6	323	194	245	0.1	24		66	43	3.3	1.1
356	8.3	4.4	209	313	322	0.2	24		137	109	3.9	1.1
354	6.6	3.9	173	179	265	0.1	10		65	23	2.7	1.4
313	7.7	4.3	98	315	259	0.1	68				3.4	1.3
455	6.3	3.4	124	238	199	0.1	53		466		2.9	1.2

BEAR	PROTEIN	ALBUMIN	FE	CHOL	TRIGLY	BILI	ALK PHOS	LDH	SGOT	CPK	GLOB	A/G
479	6.3	3.5	138	174	176	0.2	53		393		2.8	1.3
459	5.7	3.2	114	210	143	0.1	120		147	642	2.5	1.3
452	7.2	4.3	286	335	225	0.1	20		101	686	2.9	1.5
353	7	3.7	316	251	298	0.3	46		84	169	3.3	1.1
355	7.3	4	168	248	164	0.1	31		163	192	3.3	1.2
360	7.3	4	215	357	289	0.1	38		64	110	3.3	1.2
478	6.5	3.4	169	216	211	0.1	82		117	105	3.1	1.1
E-45	6.6	3.7	168	306	300	0.2	78		217		2.9	1.3
405	7	2.9	110	269	244	0.2	38		66	117	4.1	0.7
453	7.1	3.7	162	267	291	0.2	21		50	40	3.4	1.1
A-42	6.5	3.1	260	239	175	0.1	66		337		3.4	0.9
D-15	9.2	5.3	467	300	264	0.1	30		101	359	3.9	1.4
373	6.7	3.4	456	270	260	0.1	80		93	87	3.3	1
469	7.9	4	346	294	214	0.1	20		95	371	3.9	1
414	6.9	3.5	424	260	170	0.2	35		115	66	3.4	1
303	6.8	3.8	230	279	316	0.2	31		187	468	3	1.3
479	6.4	3.5	137	173	181	0.2	58		423		2.9	1.2
359	8.1	3.1	96	299	442	0.2	21		65	125	5	0.6
457	6.7	3.2	98	221	236	0.1	15		295	816	3.5	0.9
354	6.6	3.9	173	182	260	0.1	10		62	36	2.7	1.4
452	8	4.6	242	342	288	0.6	36			156	3.4	1.4
A-53	6.8	3.1	126	261	189	0.2	76		377		3.7	0.8
A-47	6.6	3.2	230	200	183	0.1	88		169	554	3.4	0.9
470	8	3.8	303	265	179	0.1	76		181		4.2	0.9
410	8.2	3.9	167	359	279	0.3	43			171	4.3	0.9
409	7.4	3.6	208	312	304	0	43		91	367	3.8	0.9
454	7.1	3.7	141	240	238	0.3	49				3.4	1.1
401	6.4	3.1	55	235	369	0.1	35		83	111	3.3	0.9
407	6.6	3.3	189	256	220	0.2	51		73	94	3.3	1
B-16	8.8	4.4	282	287	336	0.2	31		234		4.4	1
352	5.2	3.2	317	236	265	0	42		59	61	2	1.6
91	9.6	5.7	651	303	245	0.5	21				3.9	1.5
408	7.8	3.1	121	238	202		24		53	66	4.7	0.7
A-48	7	3.1	216	251	299	0.1	27	405	40	78	3.9	0.8
453	7	3.7	161	260	299	0.3	21		43	59	3.3	1.1
A-26	7.8	3	96	286	424	0.1	23	525	52	99	4.8	0.6
D-13	7.8	4.5	183	243	259	0.1	22		338		3.3	1.4
A-50	7.3	3.7	185	241	215	0.1	35		399		3.6	1
D-22	9.2	4.3	161	358	304	0.1	53				4.9	0.9
A-9	6.7	3.2	354	201	144	0.1	73	568	62	332	3.5	0.9
93	6.5	3.7	193	302	242	0.1	69		31	70	2.8	1.3
452	7.3	4.2	284	336	225	0	23		113	722	3.1	1.4
E-23	9	4.9	122	232	188	0	24		350		4.1	1.2
A-49	7	3.9	393	317	206	0.3	97				3.1	1.3
A-53	6.5	2.9	106	244	187	0.1	76		402		3.6	0.8
481	8.9	3.9	314	274	228	0.6	66			108	5	0.8
D-10	6.4	4.0	200	260	384	0.3	42		134		2.4	1.7
D-16	6.4	3.3	95	246	256	0.2	35		166	819	3.1	1.1
E-60	8.4	4.2	137	378	392	0.2	30				4.2	1
462	7.2	3.9	339	263	224	0.2	35		130	643	3.3	1.2
D-12	7.5	4.6	307	216	195	0.1	25		165	358	2.9	1.6
P-10	8.3	4.5	300	336	210	0.2	16		99	68	3.8	1.2
A-43	6.3	3.6	200	340	134	0.2	71		337		2.7	1.3

BEAR	PROTEIN	ALBUMIN	FE	CHOL	TRIGLY	BILI	ALK PHOS	LDH	SGOT	CPK	GLOB	A/G
A-48	7	3	221	250	301	0.1	27	387	43	65	4	0.8
A-45	6	3.3	327	163	159	0.2	38	545	116	592	2.7	1.2
B-17	7.9	3.8	162	197	205	0	36		206	492	4.1	0.9
A-41	6.1	3.1	292	213	173	0.2	53		185	947	3	1
P-9	5.3	3.1	226	264	170	0.2	65		58	40	2.2	1.4
C-20	8.3	4	202	241	283	0.7	43			281	4.3	0.9
H-3	6.5	3.6	357	285	215	0.3	23			92	2.9	1.2
A-54	6.2	3.1	359	296	245	0.1	72		161	662	3.1	1
H-2	4.9	2.3	179	138	81	0.1	16	450	50	37	2.6	0.9
A-47	6.6	3.1	224	202	181	0.1	85		175	626	3.5	0.9
E-24	7.7	4	210	267	114	0.2	73		152	327	3.7	1.1
C-2	8.2	4.6	337	198	184	0.2	29		80	59	3.6	1.3
A-50	7.3	3.8	146	255	226	0.2	37				3.5	1.1
D-11	5	2.7	227	192	234	0.2	85		206		2.3	1.2
A-46	6.8	3.7	356	248	162	0.2	57		412		3.1	1.2
E-31	6.7	3.4	166	266	160	0.1	39		101	204	3.3	1
P-10	8.4	4.5	323	338	204	0.2	19		90	100	3.9	1.2
A-54	6.8	3.5	283	307	241	0.3	58			927	3.3	1.1
A-43	6.1	3.6	192	340	130	0.2	70		336		2.5	1.4
P-1	6.3	3.8	370	275	266	0.2	43	326	27	80	2.5	1.5
D-14	7.7	3.5	126	206	264	0.1	23	530	37	84	4.2	0.8
142	6.3	3	256	233	173	0.2	64		319	749	3.3	0.9
A-54	6.1	3.1	354	284	247	0.2	72		140	628	3	1
A-41	6.1	3.1	280	216	170	0.2	52		185	787	3	1
83	5.7	2.8	177	177	94	0.1	21		136	20	2.9	1
A-46	7.0	3.7	370	256	162	0.2	56		461		3.3	1.1
M-83	7.4	3.8	297	223	225	0.2	38		82	119	3.6	1.1

APPENDIX E

LEPTOSPIRA SEROLOGIC SURVEY

BEAR	DATE	LOCATION	SEX	AGE	WT	CANICOLA	HARDJO	POMONA	GRIPPO	ICTERO
A-5	06/18/76	Bote Mt.	M		170					1:200
A-12	07/03/76	Bote Mt.	M	1.5	35					1:100
A-14	07/07/76	Bote Mt.	F	8.0	90					1:200
D-1	07/21/76	US 441	F	6.0	132					1:1600
C-2	07/25/76	Parsons Br.	M	7.5	270					1:200
D-3	07/26/76	Sugarland Mt.	F	7.0	85					1:100
D-5	07/28/76	Sugarland Mt.	M	0.5	15					1:100
E-3	08/05/76	Bunker	M	4.5	155	1:800				
F-1	08/11/76	Tremont	M	1.5	60	1:100				
C-9	08/13/76	Smokemont	M		350			1:100		1:100
C-8	08/18/76	Rabbit Crk.	F		110	1:200				1:100
C-12	08/23/76	Cades Cove	M	7.5		1:400				1:200
F-4	09/07/76	Sugarland Mt.	M	5.5	195	1:200				
F-6	09/09/76	Sugarland Mt.	F	1.0	60	1:200				
D-14	06/19/77	Bote Mt.	M	9.5	250					1:50
F-10	06/28/77	Sugarland Mt.	M	9.5	350					1:100
E-23	07/03/77	Parsons Br.	M	6.5	200	1:100				
E-33	08/07/77	Bunker	F	2.5	70	1:50				
M-83	08/07/77	Cades Cove	M	8.5	293	1:3200				
83	08/09/77	Cades Cove	M	9.5	300	1:400				
P-7	08/21/77	Collins Crk.	M	2.5	165					1:100
P-8	08/23/77	US 441	F	7.5	120	1:50				
301	06/23/78	Tellico	M	6.0	230	1:100				
306	06/25/78	Tellico	F	4.0	92			1:100		1:100
307	06/25/78	Tellico	F	3.0	84			1:100		1:100
360	06/30/78	US 441	M	2.0	140					1:100
461	07/01/78	Bote Mt.	M	9.0	200					1:100
464	07/09/78	Bote Mt.	M	3.0	90	1:100				
308	07/09/78	Tellico	F	3.0	95			1:100		1:100
358	08/14/78	Cosby	M		120					1:100
305	08/24/78	Tellico	F	6.0	105	1:100				
411	08/25/78	Bunker	M	2.0	70					1:100
605	05/20/79	Newfound Gap	M	5.0	200					1:500
606	05/28/79	US 441	F	8.0	120			1:500		
607	06/01/79	Cataloochee	M	3.0	170					1:500
416	06/02/79	Parsons Br.	M	3.0	75					1:500
609	06/04/79	US 441	F	4.0	150			1:2000		1:500
608	06/04/79	US 441	F	4.5	120					1:1000
334	06/05/79	Tellico	M	3.0	100					1:200
326	06/07/79	Tellico	F	1.0	30					1:500
612	06/12/79	Chimneys	M	1.0	50				1:500	
417	06/13/79	Parsons Br.	M	4.0	190			1:1000		
306	06/15/79	Tellico	F	4.0	90			1:4000		
309	06/15/79	Tellico	M	3.0	108					1:2000
576	06/27/79	Smokemont	F	3.0	90					1:500
577	06/27/79	Smokemont	F	12.0	160					1:100
492	06/27/79	Bote Mt.	M	4.0	125					1:1000
461	06/30/79	Bote Mt.	M	10.0	170					1:1000
495	07/14/79	Sugarland Mt.	M	3.0	120				1:2000	
422	07/15/79	Bunker	M	5.0	155	1:4000	1:2000			
496	07/17/79	Sugarland Mt.	M	4.0	120					1:200
498	07/27/79	Bote Mt.	F	2.0	75			1:50		
471	08/23/79	Bote Mt.	F	3.0	80					1:200
577	09/04/79	Smokemont	F	12.0	205					1:200

APPENDIX F

CANINE DISTEMPER VIRUS

SEROLOGIC REACTORS

BEAR	DATE	LOCATION	SEX	AGE	WEIGHT
452	06/19/78	Cataloochee	M	3.0	220
352	06/27/78	Collins Crk.	M	3.0	80
321	06/29/78	Parsons Br.	F	3.0	95
404	06/29/78	Parsons Br.	F	3.0	105
360	06/30/78	US 441	M	2.0	140
461	07/01/78	Bote Mt.	M	9.0	200
463	07/07/78	Bote Mt.	F	11.0	130
465	07/11/78	Bote Mt.	M	3.0	145
373	07/13/78	Chimneys	M		128
358	07/17/78	Chimneys	F	8.0	150
466	07/22/78	Tremont	M	4.0	147
467	07/25/78	Tremont	M	3.0	105
454	08/05/78	Tremont	F	9.0	85
359	08/12/78	Cades Cove	M		310
469	08/12/78	Sugarland Mt.	M	7.0	305
405	08/12/78	Bunker	M	3.5	90
E-7	08/13/78	Parsons Br.	F	7.0	125
358	08/14/78	Cosby	M		120
361	08/23/78	US 441	M	1.0	75
305	08/24/78	Tellico	F	6.0	105
410	08/26/78	Bunker	M	1.0	58
366	08/31/78	Elkmont	M	10.5	500
413	09/01/78	Parsons Br.	M	4.0	132
476	09/04/78	Bote Mt.	F	5.0	125
414	09/05/78	Parsons Br.	F	3.0	100
479	09/06/78	Bote Mt.	M	4.0	175
478	09/10/78	Bote Mt.	M	2.0	125
603	05/17/79	Cosby	M	4.0	235
604	05/18/79	Chimneys	M	3.5	98
606	05/28/79	US 441	F	8.0	120
416	06/02/79	Parsons Br.	M	3.0	75
609	06/04/79	US 441	F	4.0	150
486	06/05/79	Bote Mt.	F	3.0	75
403	06/06/79	Parsons Br.	F	4.0	95
322	06/07/79	Tellico	M	4.0	180
612	06/12/79	Chimneys	M	1.0	50
335	06/14/79	Tellico	M	4.0	155
337	06/15/79	Tellico	M	3.0	115
306	06/15/79	Tellico	F	4.0	90
402	06/18/79	Parsons Br.	M		200
613	06/22/79	Chimneys	M	3.0	140
405	06/22/79	Bunker	M	4.5	100
575	06/27/79	Smokemont	F	6.0	160
576	06/27/79	Smokemont	F	12.0	220
461	06/30/79	Bote Mt.	M	10.0	170
616	06/30/79	US 441	F	3.0	70
305	07/13/79	Tellico	F	3.0	90
494	07/13/79	Sugarland Mt.	F	6.0	65
617	07/31/79	US 441	M	0.5	17
609	07/31/79	US 441	F	4.0	140
504	08/30/79	Bote Mt.	M	5.0	150
578	09/04/79	Smokemont	M	1.5	33

VITA

William Joseph Cook, son of Carlisle and Eleanor Cook, was born in Memphis, Tennessee on 28 December 1949. He attended Treadwell High School in Memphis, graduating in 1967. He attended Memphis State University and graduated in 1972 with a Bachelor of Arts degree in biological and earth sciences. He worked as a senior research associate at The University of Tennessee Center for Health Sciences, Department of Pediatrics from 1968 until 1977. In April 1978 he was employed in Resource Management Division of the National Park Service, Great Smoky Mountains National Park, Gatlinburg, Tennessee. In 1978 he began Graduate School in the Department of Forestry, Wildlife, and Fisheries at The University of Tennessee, Knoxville. He married Patrese Hamilton in May 1982 and resides in the national park. He received his Master's degree in Wildlife and Fisheries Science in August 1982.